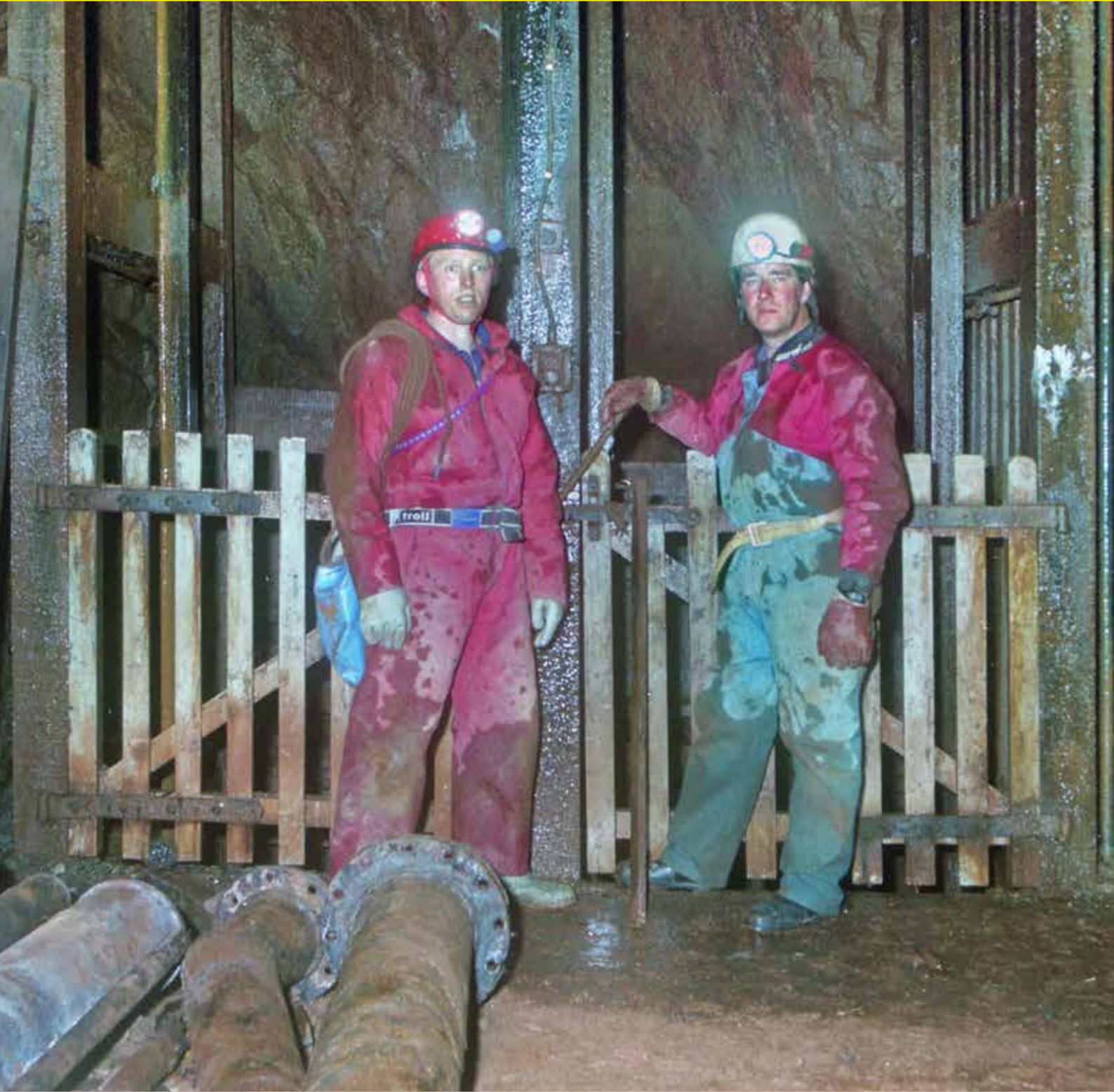


# Subterranea

The Magazine for Subterranea Britannica



**Subterranea Britannica**



**April 2019**

**Issue 50**

**IN THIS  
ISSUE**

Liverpool Weekend  
US Missile Sites

Cold War Bunker at Gravesend Part 2  
Welbeck Abbey Tunnels

Subterranea Britannica is a society devoted to the study of man-made and man-used underground structures and the archaeology of the Cold War. The society is open to all and its membership includes all walks of life. Members are invited to contribute to this magazine even if this just means sending very welcome snippets from newspapers and magazines.

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**Front cover photo:** *Sub Brit members Vince Alkins and Neil Baldwin stand by Victory Shaft gate at Level 3 in Geevor Tin Mine in Cornwall in 1991. The mine closed in 1990 the pumps were switched off in 1991 and the mine quickly flooded up to Level 3 which is the drainage level. The mine is now a popular tourist attraction. Photo Nick Catford*

**Back page upper:** *Sub Brit members on the recent Liverpool visit get a close-up view of the huge 1960s control unit for the Queensway tunnel as part of their trip deep under the Mersey. Members descended hundreds of steps down below the roadway of the tunnel itself, as well as visiting the Williamson's Tunnels complex. Photo Clive Penfold*

**Back page lower:** *Sub Brit members in the briefing room at Gravesend Cold War Civil Defence Control Centre in Woodlands Park, during a special visit for Sub Brit members on 9 March 2019. The briefing room is one of the few rooms in the bunker that hasn't been restored to its original condition. The room was the Sub-Divisional Control Room. The green cabinet on the right is an SX50 switch cabinet, part of the Government Emergency Communications Network (ECN) which was introduced during the 1980s. Photo Clive Penfold*

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Newsletters of Subterranea Britannica are published by the committee of Subterranea Britannica. Original articles, book reviews, press cuttings, extracts from books and journals, letters to the Editor etc are welcome.

However the Editor reserves the right not to publish material without giving a reason.

The committee of Subterranea Britannica and the Editor do not necessarily agree with any views expressed and cannot always check the accuracy of any material sent in.

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# Chairman's Welcome

**Martin Dixon**

Firstly a warm welcome to all new members who are reading their first *Subterranea*. January in particular brought a good influx of new joiners; your interest and funding allows Sub Brit to go from strength to strength. I hope to meet many of you throughout the year.

Sadly the magazine also records the recent deaths of four members – two of them distinguished Honorary Members. Such passing always brings mixed emotions – great sadness at the loss but tempered with happiness in remembering individuals, their contribution to Sub Brit and many successful trips together. It says something about our society that Sub Brit members are always in attendance at the funerals of former members which as well as paying tribute to their lives hopefully also acts as a measure of comfort to friends and family.

It's a privilege to be penning this welcome to what is the 50th edition of *Subterranea*. The first edition was published sixteen years ago, following a series of Newsletters, and since then we have only had two Editors: the late Dan McKenzie and long-serving Nick Catford. Over the years many improvements have been made – for example we started off in black and white, then added a centre spread in colour and technology advances mean we now have a full-colour magazine.

As well as the Editor, *Subterranea* clearly depends on a larger team to bring everything together. Firstly and most importantly, the many authors who find time to write about their interest with clarity and passion or who support articles with their excellent photographs.

Then the rest of the editorial team – the sub-editors

(myself, Linda Dixon and other Committee members); Stewart Wild our punctilious proofreader; Tim Robinson who draws superb plans and Martin Snow who manages the final layout. We shouldn't forget our printers Designosaur and the Martell mailing house who together ensure the end product is produced on time and delivered to your door.

Many thanks to all of the above for their commitment of time and energy; I look forward to reading the 100th edition in 2035.

Tony Radstone and I are recently back from a recce weekend in Berlin, in advance of the main trip in May of this year. Tony has secured some fascinating sites, mostly well off (under?) the tourist trail. I know our local contacts, in particular Berliner Unterwelten, will give us a warm welcome whatever the final outcome of the current Brexit debate turns out to be. There are many other attractions in the city for those extending their stay. During the Nottingham study weekend last October, Hayley Clark and Ed Waters made a major discovery in identifying 'Witches' marks' whilst on our visit to Creswell Crags. Witches' marks (or Apotropaic marks) are symbols and patterns carved around cave doorways and other entrances in order to keep witches and other evil spirits at bay.

Hayley and Ed's keen eyes triggered a major exercise which culminated in a Press day at Creswell to which they were invited. The story was picked up by the media locally, nationally and internationally and Sub Brit got lots of publicity along the way. Congratulations

to Hayley and Ed on their great discovery.

The marks are a perfect example of how what lies in plain sight may sometimes reveal a great deal to those with the patience to seek it out. I recall a noticeboard at an ROC Group HQ which below a long list of official numbers (Fylingdales, RAF Commands etc) had a hand-annotated addition – the phone number of the local fish and chip shop. Presumably used only on exercises, it suggested a determination to resist any battering even when the chips were down.

[chairman@subbrit.org.uk](mailto:chairman@subbrit.org.uk)



Members of Subterranea Britannica making the discovery at Creswell Crags



# SUBTERRANEA BRITANNICA DIARY

## Summary of Forthcoming Events

### Sub Brit specific events

2019

- 3 - 6 May Berlin Study Weekend
- 8 June Committee Meeting
- 13 June Standedge Tunnel Trip
- 1 July Copy deadline for *Subterranea* 51
- 5 August Mail Rail Trip no.4
- 31 August *Subterranea* 51 published
- 19 October SB Autumn Meeting
- 1 November Copy deadline for *Subterranea* 52
- Mid-December *Subterranea* 52 published

### Other underground-related events

2019

- 11 May Reigate Caves Open Day
- 18 - 27 May Fortress Study Group - Study Tour to Greece
- 20 - 26 May Hypogea 2019, Dobrich, Bulgaria
- 8 June Reigate Caves Open Day
- 4 - 8 July NAMHO Conference 2018, Wales
- 13 July Reigate Caves Open Day
- 10 August Reigate Caves Open Day
- 9 - 14 August AIA Conference, Somerset
- 13 - 22 September Heritage Open Days, England
- 21 - 22 September London Open House
- September (tbc) Heritage Open Days, Scotland, Wales & N. Ireland

For web links to these events please visit [www.subbrit.org.uk/events](http://www.subbrit.org.uk/events)  
or contact the organisation concerned

*If you know of other relevant events run by other societies, please let us know  
so that they can be advertised in the next edition and on the website*



# Honorary Member Harry Pearman 1934 - 2019

## Paul W Sowan

Harry Pearman died on 26 February 2019 aged 84 as this magazine was about to go to print. He was made an honorary member of *Subterranea Britannica* in recognition of his pioneering work accumulating and publishing, over many years, as many details as he could discover for subterranean sites in the home counties, mostly man-made although with a handful of such few natural caves as are known in southeast England.

Harry's interest in things subterranean commenced with caving as a member of a Scout troop in Chelsea in the 1950s, he in time becoming a senior member of the Chelsea Spelaeological Society which continues to flourish today. He became a specialist in IT and data processing, and worked for the GLC and other local government bodies.

A short-lived London Spelaeological Group published two volumes of *Records* in 1959 and 1960, containing notes on some home counties sites. As there was and is little scope for exploring natural caves anywhere near London, much attention was devoted especially to Surrey, where the several very extensive Godstone quarry tunnel labyrinths provided much scope for exploration.

Amongst Harry's earliest published contributions are notes on the 'Guildford Castle caves' and the Barons' Cave at Reigate, which appeared in the Chelsea Spelaeological Society's earliest Newsletters. From about 1960 onwards he was a member of a team digging out a back-filled Roman well at Findon on the South Downs in West Sussex. This was a prodigious undertaking, as the well had been completely back-filled. By 1968 a depth of 210 feet had been reached without finding the bottom. From 1963 onwards the *Records of the Chelsea Spelaeological Society* series of accounts of southeastern sites commenced, with *Secret tunnels in Surrey*, for most of which Harry was author or co-author.

So prolific is Surrey in underground sites that *More secret tunnels in Surrey* was published in 1968, the joint authors being Harry, John Henderson, and Brian Hillman. Subsequent issues were devoted to Kent, and to dene-holes most of which are in Kent and Essex. The entire series of thirty or so volumes is largely devoted to additional records for 'caves and tunnels in southeastern England' with just a few dealing with natural caves elsewhere. The author of this note was one of numerous enthusiasts submitting material for inclusion in these volumes.



The *Secret Tunnels* series brought together field observations, newspaper articles, odd references in local history books, and official publications such as those concerning the collapse of houses at Plumstead into a forgotten chalk mine.

Harry and the Chelsea society concerned themselves with all manner of underground man-made and man-used sites in southeastern England a good ten years or more before *Subterranea Britannica* took an interest in such places nationwide, and indeed in mainland Europe and beyond. In east Surrey detailed surveying and historical research has been built on Harry's early descriptions thanks largely to the Croydon Caving Club and, more recently, the Wealden Cave and Mine Society. Alongside his home counties work he remained an active caver elsewhere in the British Isles, and was a member of the William Pengelly Cave Studies Trust to whom he left most of his library and archive.

Later in life, Harry bravely fought the effects of Parkinson's disease for many years. He found it frustrating when it meant he was no longer able to undertake exploration himself but his rich published legacy and detailed plans form an invaluable record of his many underground excursions.

We extend our sympathies to his wife Heather, his two sons and numerous grandchildren.

## References

PEARMAN, Harry, 1963, *Secret tunnels in Surrey*. *Records Chelsea Spelaeological Society* 3: 61pp.

PEARMAN, Harry, John HENDERSON, and Brian HILLMAN, 1968, *More secret tunnels in Surrey*. *Records Chelsea Spelaeological Society* 5: ii + 81pp [Reprinted 1983].



# Mike Barton 1939 - 2019

## Robin & Jane Ware

Former Sub Brit member and peerless bunker trip organiser Mike Barton, who will be known to many members, has died in Germany aged 79 where he had lived for around 40 years.

Mike served in the Army from the late 1950s to the late 1970s. He initially served as a Corporal in a SIGINT unit in West Berlin. He was soon assigned to a military language school to learn Russian, and advanced in rank quickly. During one of his tours of duty in Berlin, he volunteered to serve as a rotational commander of the British Military Train, which carried soldiers and their dependants between Berlin and West Germany.

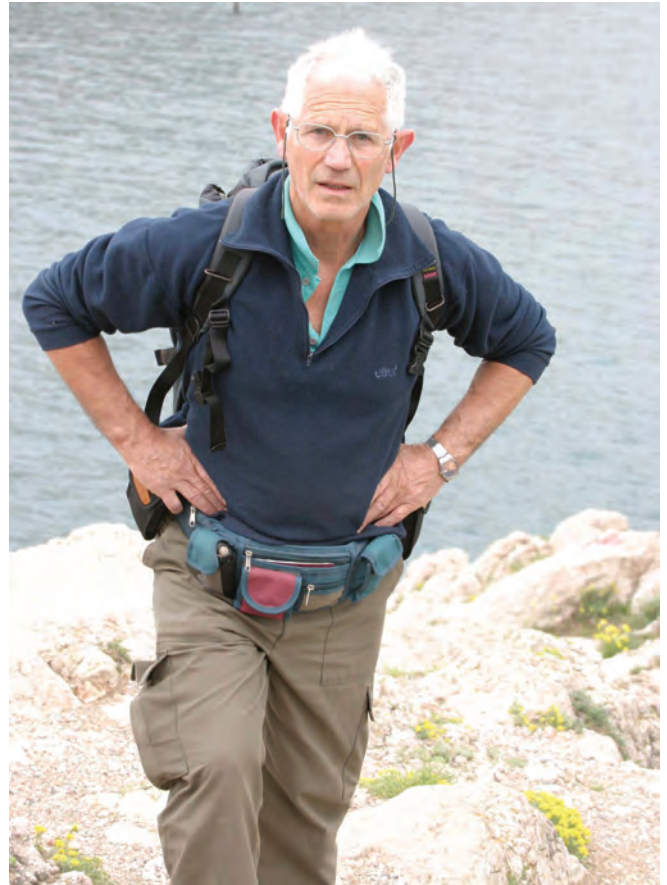
Most of his career was spent with the Royal Army Educational Corps, and he served as an Educational Specialist with the SAS, from which he eventually retired with the rank of Major. By this time, as well as having taught Russian to Special Forces, he had also become fluent in German, Italian and French. His favourite lesson was teaching people to greet a Russian by saying, very quickly, "Does-your-arse-fit-ya?"

Having left the army, Mike joined Siemens in Erlangen as a translator and became the head of one of two technical translation teams - in true Mike style, the more successful one. He remained with the firm until he retired in 1999 and was in regular contact with friends from Siemens up until the time of his death.

After retiring, Mike began researching the spread of the military and government communications network in the UK as a hobby. Whilst in the UK on holiday he was persuaded by a friend to join *Subterranea Britannica* and attend the Day Conference at Hack Green in 2000. He was intrigued by what he saw and at the end of the meeting asked if anyone would be interested visiting any East German military sites, probably not expecting the eager response that was forthcoming. It is worth noting that he had yet to visit any East German sites or bunkers himself, and only vaguely knew that they must exist somewhere! The following year he organised the first coach trip, which was a great success and unforgettable for those who took part. Although he frequently said "Never Again", there were many car trips and another coach trip in 2008.

As well as these visits, Mike also conducted extensive research into the history of the Soviet sites and military command structure in East Germany, contacting those who were in charge of running the sites during their operational life and also former members of the Red Army. Never forgetting Sub Brit, he also gave several presentations at further Day Conferences.

Some of the German bunkers are now being restored or maintained and he devoted many hours to assisting these projects, most notably at Kunersdorf and Zossen-Wüns-



dorf. He spent days on site surveying the buildings and generating accurate CAD 3-D models with the help of a local friend. Mike's house was decorated with many bunker artefacts which amused the friends who stayed with him, including a few Sub Brit members over the years. He never got round to replacing his front door with a blast door, but often thought about it.

Mike married twice, sadly both marriages ended in divorce, but he had a wide network of friends and was adopted by many kindly "neighbourettes" as he fondly referred to them. He deliberately cultivated his image as the mildly eccentric English expat, with his very dry sense of humour and love of banter which he used with British and German friends alike. Less immediately obvious was the extremely generous side to his nature. He was of the opinion that if he could help, then he would, and was more than happy to help teach the neighbours' children to speak English. He was also a long-term supporter of the Gurkha Welfare Trust and other charities, he also stepped in quietly to help several individuals whom he knew were suffering hardship - in one case helping to provide a motorised wheelchair for a former Warsaw Pact soldier who had suffered a stroke.

There have been many reports of German bunker trips in *Subterranea* over the years. The majority of these have their roots in Mike's original offer, and the Society has much to thank him for.



# Honorary Member Barbara Mary Tadd 1925 - 2018

## Paul W Sowan

We are sad to report the death of Barbara Tadd on 17 December 2018 aged 93. She and her husband Malcolm were elected Honorary Members of Subterranea Britannica in recognition of their long service to our society as joint secretaries. In that capacity, for some years they masterminded our affairs and organised production of our journal, arranged day conferences, and study weekends, as well as attending to committee documentation and general administration. Sub Brit has been fortunate in having such stalwarts at the helm.

Barbara was born in Brighton on 19 March 1925, and her childhood was spent on various farming estates in the Home Counties at which her father worked. After a short spell as a shop assistant she went into nursing, and worked briefly in Scotland and also at Heatherwood in Ascot – then a TB hospital. Barbara was a committed Catholic and her faith remained important to her throughout her life.

Barbara met Malcolm (coincidentally also from Brighton) in the Lake District in 1956 and they married the next year. In 1958 they set up home in South Nutfield, near Redhill, in east Surrey, where their two children Jimmy and Cathy were born in 1960 and 1963. Barbara sought work closer to home to help her balance her family commitments and her last employment was at Nutfield as an assistant for the Brewery Research Foundation where amongst other things she helped to organise a beer-tasting panel.

Barbara and Malcolm were enthusiastic cyclists and walkers in the Surrey countryside, and at South Nutfield became members of the then local caving club Unit Two Cave Research and Exploration, now the Wealden Cave and Mine Society. Later both Barbara and Malcolm joined Subterranea Britannica and their long period of involvement and contribution began. As well as being justly elected as Sub Brit Honorary Members after their retirement from the Committee, Malcolm has for some years been President of WCMS.

Both Subterranea Britannica and the Wealden Cave and Mine Society were well represented at Barbara's funeral held at St Joseph's R.C. Church at Redhill on a damp day in mid-January. The service itself was uplifting and



part of Barbara's life story had been dictated by Barbara herself in a great example of both her excellent memory and forward planning.

Malcolm himself gave part of the Eulogy and touchingly described Barbara's many gifts. She was always welcoming to newcomers and was able to fill her life and others with jokes and laughter. Together they went into lots of places that perhaps they shouldn't have but an occasional 'turfing out' was more than made up for by the making of a growing circle of like-minded friends.

In later years Barbara's sight failed but this never stopped her venturing out both socially and to continue to satisfy her fascination with local history and industrial archaeology. Malcolm and Barbara spent 61 years together and our deepest condolences are sent to Malcolm and the rest of the family for their loss which many of us also keenly feel.

St Barbara is, of course, the patron saint of miners and artillery and we have been fortunate indeed to have had her namesake helping support and develop Sub Brit over so many years.

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# Simon Norton 1952 - 2019

## Stewart Wild

We have lost, mathematically at least, one of most brilliant members. Simon Norton, who died aged 66 of heart failure on 13 February this year, was an Eton-educated maths prodigy whose skill with numbers was recognised from early childhood. When his mother arranged for an IQ test for her three-year-old son, Simon had an IQ of 180, well above genius level.

As a teenager he competed in the International Mathematics Olympiad, attaining the top score three years running. He excelled at bridge, chess and backgammon and obtained a First in Pure Mathematics as an external degree from London University whilst still at school.

Simon Phillips Norton was the youngest of three brothers born in London to a wealthy family of Iraqi Jewish



ancestry. After Eton he went up to Trinity College Cambridge where he took another First and stayed on, working with colleagues on complex mathematical projects including the *Atlas of Finite Groups* (1985) which maps the symmetries of the universe.

He had a large house in Cambridge where he chose to live in the basement, whilst renting out the rest of the property to friends and colleagues. One of his tenants, Alexander Masters, wrote a memoir in 2011 entitled *The Genius in my Basement: The Biography of a happy man*. Reference was made to the chaotic state of Simon's living quarters where 'untidy' would be an understatement; apparently he lived among a jumble of books, papers, bus timetables, supermarket bags, empty plastic bottles and discarded clothing.

In the mid-1980s Simon underwent some sort of change or mental breakdown. He continued to publish excellent work and give outstanding talks at mathematics conferences around the world, but he seemed to have lost his focus. He was never a smart dresser but he became increasingly dishevelled and wore battered clothing and mutton-chop whiskers.

Even as a child he had always enjoyed bus travel, and he became more and more interested in public transport, travelling all over the country by bus and train and writing magazine articles about how our bus and rail networks could be improved. His rail journeys included East Germany and Russia.

After Cambridge, Simon had moved to London where he joined Sub Brit in the summer of 2014. He was an active member, participating in at least a dozen SB visits over the next four years, although his slight shyness and unkempt appearance encouraged few friendships and raised a few eyebrows. He hated spending money, saying



that it risked dragging oneself into a spinning vortex where eventually there would be nothing left.

Behind the scenes, however, he was most generous, giving £10,000 every year towards a prize for a transport activist or campaigner. In 2008 the recipient was a member of the campaign group *Plane Stupid*, who at a Downing Street reception superglued himself to Prime Minister Gordon Brown in a protest about a proposed third runway at Heathrow. Simon was delighted.

He was a loyal and generous supporter of Transport 2000, which in 2007 became The Campaign for Better Transport. At his standing-room-only funeral at Golders Green, conducted by Rabbi Baroness Julia Neuberger, a long-time family friend, it was revealed that he had left the majority of his money to transport causes and Voluntary Action groups.

Afterwards, those attending were offered a ride aboard a 1968 RTL London Routemaster bus to Hampstead and Belsize Park, where he had collapsed eleven days earlier, in memory of a remarkable man.

## An 1822 Ordnance Survey tunnel puzzle

The Ordnance Survey was established in 1791, as its name suggests, initially for defence purposes. Naturally, that part of England surveyed first was Kent, most obviously at greatest risk of invasion by the French, especially in due course led by Napoleon Bonaparte [1769 – 1821]. The Survey, for the purposes of its early one inch to the mile published maps, in due course introduced 'conventional signs' to indicate, especially, strategically important features and landmarks. Two pages of a pre-1822 table of these signs appear in Harry Margary's reprinted Ordnance Survey 'early state' one-inch maps (Volume III which includes Surrey).

Curiously, a conventional sign is included for a road tunnel, although Britain's earliest surviving example (made at Reigate around 1820 – 24) does not appear on the map. Even more curiously, there are conventional signs for various features of canals and tramways (such as locks, towpaths, aqueducts, and inclined planes) but not for canal tunnels, although a number had been made

before 1800. The Basingstoke Canal made in 1792 – 1794, appears on the map, but the 1230 yards Greywell tunnel is not specifically identified as such.

This raises two questions. Why was there, at this time, no symbol for a canal tunnel; and was a road tunnel symbol created in anticipation of such a feature, or perhaps because the first British road tunnel (at Highgate) had been commenced in 1809 / 10 although not completed (it collapsed unfinished on 13 April 1812)?

SOURCE: MARGARY, Harry, 1981, *The Old Series Ordnance Survey maps of England and Wales. Scale 1 inch to 1 mile. A reproduction of the 110 sheets of the Survey in early state in 10 volumes. Volume III. South central England. Hampshire and the Isle of Wight and parts of Berkshire, Dorset, Somerset, Surrey, Sussex and Wiltshire. Introduction by J.B. Harley and Yolande O'Donoghue*. Lympne Castle: Harry Margary: lvi pp + 80 maps [ISBN 0-903541 – 03 – 3]





# NEWS

Miscellany compiled by Paul W Sowan and Nick Catford

## NEWS – ARCHAEOLOGY

### The Red Lady of Paviland, South Wales

Culver Hole and Paviland Cave are natural solution caves in the Carboniferous Limestone of the Gower Peninsula, to the west of Swansea. In 1823 elephant bones were discovered in Paviland Cave, resulting in an archaeological excavation which revealed a human skeleton of unknown age, stained red by ochre (natural iron oxide).

Guesses at the nature of the skeleton included a relatively recently murdered Customs Officer going about his business in pursuit of smugglers, or a much older (Roman era) prostitute, on the strength of a sea-shells necklace and the proximity of a supposed Roman hillfort. The skeleton became known as the ‘Red Lady of Paviland’.



*Paviland Cave*

Further examination and measurement of the bones in 1912 led to the conclusion that the remains were of a man, probably a hunter-gatherer. The most recently determined carbon-14 data suggest he lived and died as much as 33,000 years ago. Whilst the Cave is, today, tricky to get to, accessible either via rocky ledges on the cliff or dodging waves on the beach, the prehistoric landscape of 33,000 years ago would have been very different on account of rises in sea-level since then. Both human beings and woolly mammoths could have entered the cave without difficulty.

SOURCE; VOYSEY, Mandy, 2018, Paviland Cave and Culver Hole ahoy! *Newsletter Chelsea Speleological Society* 60 (7/8/9), 54–56.

### Non-destructive archaeology finds military fort beneath Alcatraz, USA

Alcatraz prison is best known for once housing notorious criminals, but a recent discovery has revealed relics from the site’s former role as military fortification. Now, archaeologists have used ground-penetrating radar data and terrestrial laser scans to non-destructively uncover a hidden military traverse underneath the prison.

The team also made use of georectifications – where old digitised maps are linked to a coordinate system so that

they can be accurately geolocated in 3D space – to locate and assess the historical remains. The team’s methods revealed remnants of buried structures – including a bombproof earthwork traverse along with its underlying vaulted brick masonry tunnel and ventilation ducts beneath the prison recreation yard.



*Alcatraz Fort*

The remains of these historical archaeology features were just a few centimetres beneath the surface and they were miraculously and impeccably preserved. The concrete veneer of the prison recreation yard floor is incredibly thin and, in fact, in places sitting directly on top of the architecture from the 1860s. Some of the earthwork traverses were covered over with thin concrete layers through time, likely to decrease erosion on the rainy windy island.

Prior to developing a reputation as America’s strongest prison, Alcatraz Island was a 19th-century coastal fortification.

SOURCE: *The Engineer*, 28 February 2019.

### The writing on the walls at Chaldon quarries, east Surrey

Perhaps most scribbling and drawings on walls encountered today, often public lavatory walls, seems to reflect popular preoccupations with excretion and sex. Indeed, your scribe seems to recall that the word ‘pornography’ derives from Greek terms for rude things written under archways. Graffiti of a similar kind dating from the 1920s can be found on the walls of a small chalk mine at Yattendon in Berkshire.

Chalk, charcoal and candle soot inscriptions, all old and some dated and none of them obscene, can also be found in the underground building-stone quarries at Chaldon, and are to be systematically recorded and analysed by Peter Burgess and other members of the Wealden Cave and Mine Society.

Three categories have been recognised: functional marks such as tallies or aids to block extraction; so-called ritual marks made by superstitious quarry-workers for protection from bad luck or perhaps supernatural forces, and casual marks such as names and dates left by visitors.





Verse and 1609 date in Chaldon quarry. Photo Nick Catford

The dated graffiti include four lines of verse dated 1609 which a handwriting expert has confirmed to be in a style from that time, and several names, initials and dates from around the 1720s found associated with clay tobacco pipes of the kind then in use. The verse, sadly, is no more than a homily along the lines of ‘carpe diem’ and tells us nothing about the quarry or the quarrymen.

SOURCE: BURGESS, Peter, 2018, Chalk inscriptions recording project. *News of the Weald* 103.

#### **Possible 16th-century graffiti found at Creswell Crags, Derbyshire / Nottinghamshire**

Subterranea Britannica members visited Creswell Crags during the 2018 Study Weekend based at Nottingham, and were given a guided tour of several of the caves adorned with ice age art, depictions of animals and birds made in the last Ice Age discovered in 2003.

Examination of what have hitherto been regarded as Victorian-era graffiti on a cave wall has led to the marks being reinterpreted as letters, symbols and patterns scratched onto the limestone walls as apotropaic or anti-witch marks possibly made as long ago as the sixteenth century. They are reportedly the largest concentration of such marks, some hundreds if not almost a thousand, known in the UK.



The purpose of such marks, which are also known in old houses and churches, was supposedly to gain protection from witches and their curses. Characteristic of such marks are symbols consisting of overlapping pairs of the letter V, symbolising Mary, Virgin of Virgins. Also to be found are PM (Pace Maria) and Christian crosses. There is no public access to the cave containing the marks. The Creswell Heritage Trust is considering a

multi-media presentation for visitors to this already attractive and atmospheric visitor attraction.

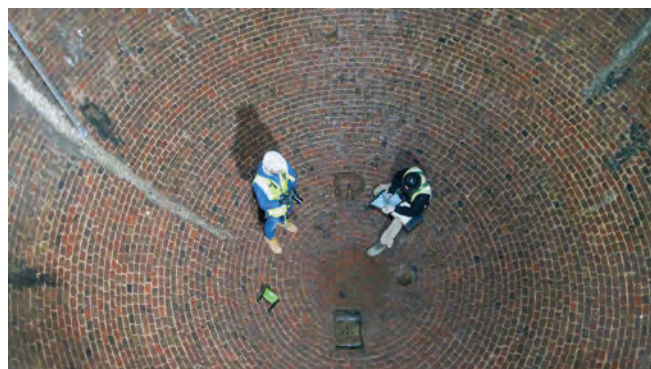
SOURCE: BROWN, Mark, 2019, Is this the gateway to hell? Hundreds of anti-witch marks found in Midlands cave. *The Guardian*, 15 February 2019, page 23.

#### **18th-century commercial ice-house discovered by Regent’s Park, London**

Building work at Park Crescent West, to the south of Regent’s Park, has revealed an enormous commercial ice-house thought to date from the 1780s. The egg-shaped brick-built subterranean void is 9.5 metres deep, with a diameter of 7.5 metres. When found, it had been back-filled with demolition rubble which has now been removed.

Some 40 years after the structure was created, John Nash built a prestigious terrace of grand houses above the site. The building rubble backfilling appears to date from WWII bombsites, the store having remained in use until the 1820s or later. Ten metres below it runs London Underground’s Jubilee line tunnels.

At the time this structure was made, ice was imported into London in large quantities from Norway, and stored underground, to supply wealthy discerning Londoners with ice for chilled summer drinks. In modern times, such a luxury is available to almost everybody thanks to modern domestic refrigerators.



This is the earliest known large commercial ice-house, and has been Scheduled by Historic England as an Ancient Monument. There are plans to provide for occasional public access at selected dates,

Two less impressive commercial ice storage pits can be seen at the London Canal Museum near King’s Cross station, and visitors can peer into a smaller-scale ice-house at Kew Gardens. Members may know that the definitive book about ice-houses, incorporating a gazetteer of identified sites, was written by SB founder Sylvia Beamon and Susan Roaf. The details are BEAMON, Sylvia P., and Susan ROAF, 1990, *The ice-houses of Britain*. Routledge: xvii + 553pp [ISBN 0-415-03301-2]

SOURCES: ADDLEY, Esther, 2018, Chilling discovery: site works reveal 18th-century ice store. *The Guardian*, 29 December 2018, page 32; ANON, 2019, Marylebone cold case. *Current Archaeology* 29(12)(348), page 8.



## Two new Roman period tombs found in Egypt

In early January Egypt's Ministry of Antiquities announced the unearthing of two Roman-period tombs at the archaeological site of Beir Al-Shaghala in the Mout village at the Dakhla Oasis.

Located on the eastern side of the archaeological site, the tombs were found adorned in colours, and depicting scenes from that period. The discovery is a part of the excavation works which were being carried out at the area since 2002, and resulted in the revelation of a total of 10 incomplete sandstone tombs from the Greek era.



Despite being located near each other, each of the two tombs differ in their architectural structures. The first tomb was found to be built from sandstones. The second tomb, on the eastern side of the first one, is made from mud bricks, yet its decorations are more vivid and carved with brighter inscriptions and ornaments. It includes paintings which depict the mummification process of the deceased. SOURCE: *Daily News - Egypt* 17 January 2018

## NEWS – CONSERVATION AND HERITAGE

### Slate quarrying landscape World Heritage Site proposal, North Wales

The UK government is allowed by UNESCO World Heritage Site rules to nominate one additional British site for consideration each year for the world list. The Gwyneth slate quarrying landscape of North Wales is to be put forward, comprising the open quarries, the entrances to the underground quarries, the mountainous waste slate spoil tips, remains of associated industrial buildings and plant, transport infrastructure and workers villages, chapels and so forth.

The region exported slate worldwide during the 19th century, primarily as a durable roofing material. As slate can be split into very thin sheets, it had a great advantage in terms of bulk and weight over fired clay tiles. The result of the selection process is expected in 2021. If successful, this will be the fourth WHS for Wales, the existing sites being the Blaenavon industrial landscape (ironstone mining, iron furnaces, &c), Edward I's 13th-century castles and town walls at Beaumaris, Caernarfon, Conwy, and Harlech, and the Pontcysyllte aqueduct at Llangollen. The UK as a whole currently has 31 World Heritage Sites. Worldwide 167 countries have more than 1,092

sites. Italy has the greatest number at 54. Selected sites include man-made landscapes and structures of all ages from prehistoric to modern, as well as entirely natural landscapes of exceptional interest. Currently, the Jodrell Bank telescope is under consideration by UNESCO. Recognition as a WHS is advantageous in securing recognition and conservation, and in attracting onward investment for example by tourism.

SOURCE: BROWN, Mark, 2018, Welsh slate landscapes up for UNESCO world heritage status, *The Guardian*, 24 October 2018, page 6.

### Stunning restoration of King Tut's tomb

The tomb of Tutankhamun has fully reopened following a decade-long restoration project. Researchers from the Getty Conservation Institute painstakingly cleaned the huge wall art in the tomb – but decided to leave a series of strange mysterious 'dark spots' that were there in 1922 when archaeologist Howard Carter first opened the tomb. The fully restored north wall of the burial chamber depicts three separate scenes, ordered from right to left. In the first, Ay, Tutankhamun's successor, performs the 'opening of the mouth' ceremony on Tutankhamun, who is depicted as Osiris, lord of the underworld.



In the middle scene, Tutankhamun, dressed in the costume of the living king, is welcomed into the realm of the gods by the goddess Nut. On the left, Tutankhamun, followed by his *ka* (spirit twin), is embraced by Osiris.

SOURCE: *MailOnline*, 23 January 2019.

### Underground in Luxembourg

Luxembourg, one of the smallest countries in mainland Europe, has a number of publicly accessible underground sites well worth visiting. In Luxembourg City itself there are two sets of rock-cut casemates in a scenically spectacular setting in the cliffs of a river gorge which divides the city into parts linked by bridges. As at the similarly sited New Mills in Derbyshire, the gorge floor is largely occupied by very agreeable public open parkland. The casemates visited by your scribe are a tourist site offering self-guided tours, strongly resembling parts of the older Gibraltar fortifications, dark tunnels leading to gun positions offering views of the gorge.

Highly recommended on the southern boundary of Luxembourg, near the French border, is the very



extensive Hirschberg and Walert ironstone mine at Rumelange which offers what your scribe would describe as a ‘five-star’ public tour as well as a surface museum and visitor centre. The two-hour underground tour is by electric train, with opportunities at various places to get off and walk about.



*Rumelange ironstone mine*

Most of this museum’s larger exhibits, primarily mining machinery, are still there to be inspected underground. This is a guided tour conducted in French, but English-language audio devices are available. A number of Subterranea Britannica members visited this mine during a SFES conference in Rumelange in 2009. The admission charge of nine euros is excellent value for money.

Luxembourg had a major iron and steel industry from around 1850 until 1997, the last underground mine being closed in the 1980s (there was also opencast mining). There are additionally extensive surface structures, where blast furnaces once lit up the night sky, in the neighbourhood. The ore deposit here was also at least as intensively worked in the adjoining Alsace Lorraine area of France. The museum and underground visit are described in more detail in the cited article.

SOURCE: JONES, Chris, 2018, Underground Luxembourg? *Descent* 265, page 17.

#### **Technical guide for owners of ‘caves’ at Nottingham**

Nottingham City Council is aware of around 850 man-made rock cut ‘caves’ excavated in the local sandstone, most of them within the boundaries of and below a multiplicity of privately owned properties, including numerous public houses. The earliest known ‘caves’ date from AD 893.

Hitherto, many of these voids, coming to light as road collapses or during foundation works for new buildings, have been regarded as nuisances, often filled-in and unrecorded. A handful have enjoyed recognition as heritage assets and tourist attractions, such as Mortimer’s Hole at Nottingham Castle, the ‘City of Caves’ below the Broadmarsh shopping centre, ‘caves’ forming part of the Brewhouse Yard Museum, and the ‘cave bars’ at the *Trip to Jerusalem* public house.

There is now a more enlightened approach by the City planners, and the post of City Archaeologist has recently

been created. All known ‘cave’ sites are now being recorded and investigated, including site investigations and archival research. A Technical Guide has recently been prepared for ‘cave’ owners, providing advice on how best to treat these historic voids, with an emphasis on appropriate investigation, recording, development and conservation. Nottingham justly claims to have a higher number and density of subterranean underground sites, and is setting a good example for other local authorities. SOURCE: *Descent* 264 (2018), page 4.

### **NEWS – HEALTH AND SAFETY**

#### **Cave rescue reports for 2015 and 2016**

Each year the British Cave Rescue Council collates and publishes details of events where regional cave rescue organisations respond to requests for assistance, either from organised groups of underground explorers or from landowners or occupiers or the emergency services at caves, mines, wells and sundry underground places.

The cave rescue organisations are typically composed of members of local caving and mining exploration clubs. They accumulate equipment specifically for their work, and generally organise cave rescue practices at various locations. Ambulance, Fire and Police services personnel generally attend at the surface, but are not usually suitably equipped or experienced to go underground.

The summary report for **2015** presents brief details for the most significant 31 incidents in caves and mines in Britain and Ireland in that year. There was one fatality resulting from a large rockfall in Bull Pot, West Kingsdale, a natural pothole. The 50-year-old male caver suffered multiple severe injuries and died underground. Three minor incidents are reported involving tourists in public show caves, one in Blue John Cavern, Castleton, and two in White Scar Cave, Ingleton.

Significantly, in eleven cases cavers were overdue returning to daylight. They had followed best practice by ensuring that somebody on the surface (a) knew where they were going and (b) knew what time they were expected to exit the cave. Parties telephone the responsible person on exit at the pre-arranged time and, if overdue, Cave Rescue are alerted. Late surfacing was the result of slower progress underground than expected due to tiredness or problems with route-finding. In one case, poor telephone reception was responsible, and in another there was confusion about the pre-arranged exit time.

Most of the incidents were in natural caves, but those of most interest to members of Subterranea Britannica were in man-made mines or underground quarries, specifically at Old Ham ironstone mine at Clearwell, Forest of Dean; Mouldridge Mine, Pikehill; Bowden Hill limestone mine, Linlithgow; and Box quarry, Corsham.

The **2016** Cave Rescue report has just been published. Details for seven underground-related incidents are reported. There were two fatalities. In the Youlgrave



area of the Peak District the Derbyshire CRO was called out by the emergency services in March 2016 to assist with a search for an elderly man (83) reported missing from home. Searching a number of open mine shafts and accessible mine workings failed to locate the man, whose body was subsequently found by a member of the public lying in a stream in Bradford Dale. A total of 18 cavers spent six hours on the search at which a local Mountain Rescue team and a Coastguard also attended.

At Tetbury, Gloucestershire, a woman aged 58 had fallen into and drowned in a 15-metre-deep well. Members of the Gloucestershire CRO attended and advised Fire Service personnel who retrieved the body.

The most serious actual underground incident was when an experienced caver aged 49 was struck by a falling rock in James Hall Over Engine Mine at Castleton, suffering suspected head, neck and shoulder injuries. He managed to complete climbing the Leviathan pitch and was stretchered out by way of an awkward route, a rescue team of 52 persons taking altogether some eight hours. Less serious were two incidents involving tourists in public show caves, who suffered minor injuries as a result of falling over.

Most of the other call-outs were to assist persons too tired to climb; one group lost their way, another group were marooned underground as a result of another group losing their way out and being overtaken to the exit by others who assumed they were last out and de-rigged a pitch. One girl of 12 became 'physically stuck' but had wriggled free before help arrived.

At Dowkerbottom Cave, Lower Littondale, police requested an investigation of a reported Wellington boot stuck upside down, presumably in a crevice or under a rock. There was no foot in the boot, which had been placed over the end of a drainage pipe! A report on 90 surface incidents, including twelve fatalities, is to be published in due course.

SOURCE: BRITISH CAVE RESCUE COUNCIL, 2018, Cavers rescuing cavers. *Descent* 265, 22–23; BRITISH CAVE RESCUE COUNCIL, 2019, Cave rescue 2016. *Descent* 266, 42–43.

### **Three rescued from US coal mine**

Three people have been rescued after spending almost five days trapped in an abandoned US coal mine. A group of four people was reported missing on 9 December after their all-terrain vehicle was found near the mine in Whitesville, West Virginia.

One member of the group was able to find his way out of the mine after two days inside. On 12 December, the rest were found by rescuers and brought to hospital. The group – ranging in age from 21 to 43 – is suspected of entering the mine to find copper wiring. They claimed copper wire was worth almost \$4 (£3.20) a pound and that they could go into a mine and make \$1,000 a day!

Police say the group were attempting to steal copper and may face criminal charges for theft as well as trespassing. It's reported that the rescue cost the state nearly \$1m for emergency pumping and ventilation (after bad air was encountered by the rescuers). The group were found in separate locations, almost 4,000ft underground in the mine, which has been closed for two years.

SOURCE: *Below*, journal of the Shropshire Caving & Mining Club.

### **'Rat-hole' miners trapped, India**

Indian Navy divers were deployed to rescue 15 workers trapped inside a flooded illegal coal mine at Ksan in the East Jaintia Hills district of Meghalaya. On December 13 floodwater from a nearby river poured in to the 370ft deep coal mine, trapping the miners. Initial rescue efforts by India's National Disaster Response Force (NDRF) and State Disaster Response Force (SDRF) were hampered by a lack of equipment.

On December 31, a Navy diver reached the bottom of the mine, but found only coal at the mouth of the level. 'Rat-hole' mining is so named because men dig narrow crevices to extract coal, creating dangerous, tight, narrow workings. Workers, including children, descend into the mines using bamboo ladders and accidents are common.

The practice was banned in 2014 by India's National Green Tribunal following a petition that said the acidic discharge from the mines was polluting the Kopili River. Mine owners in Meghalaya and the State government have challenged the ban. It is estimated there is 576 million tonnes of coal reserves in Meghalaya.

Most of Meghalaya's illegal miners are migrant labourers who come from neighbouring states to earn money. They can typically earn 30,000 Rupees (£340) every month – more than three times the money they would make working as masons and far more than agricultural labourers.

SOURCE: *Below*, journal of the Shropshire Caving & Mining Club.

### **30 die in Afghanistan gold mine**

At least 30 people have been killed in the collapse of a gold mine in the Kohistan district of Badakhshan province, northeastern Afghanistan.

Villagers had reportedly dug a 220ft-deep shaft in a river bed to hunt for gold and were trapped when it collapsed. At least seven other people were injured and 13 workers were rescued. Many of the dead are said to be children.

Afghanistan has vast resources of minerals but many of the mines are old and poorly maintained, creating severe safety issues. Afghanistan's vast resources remain largely untapped due to the conflict with the Taliban, which has seen a rise in illegal mining both by villagers and Taliban fighters who use it as a key source of revenue.

SOURCE: *Below*, journal of the Shropshire Caving & Mining Club



## NEWS – MILITARY AND DEFENCE

### World War I tunnels at National Shell Filling Factory No. 6, Nottinghamshire

A recently published booklet describes the National Shell Filling Factory No. 6 at Chilwell near Beeston in Nottinghamshire, and the explosion of 6,000 tons of TNT in the mixing plant on 1 July 1918. Almost 140 of its workers were ‘sent sky high’ and 250 more were seriously injured. The cause of the explosion was never established.

The factory was built on a 200-acre site in 1915 and eventually employed 6,000 workers, a third of them women. By the end of the war, 19 million filled shells had been produced. Tunnels were made in a wooded hillside at or near Hobgoblin Wood to store explosives.

Perhaps Subterranea Britannica members living in the district can ascertain the exact location and present state and status of the tunnels?

SOURCE: DEAN, Marian, 2018, *Remembering the Chilwell Explosion of 1918 and the Canary Girls*. Ilkeston: Erewash Museum: 10pp.

### WWII bunker in Alderney to be cleaned and opened to the public

A Second World War bunker in Alderney is being transformed into a new ‘information point’. The fortification opposite the Braye Beach Hotel and the First and Last will become accessible to visitors with displays telling people of its history.

The bunker had previously become a dumping ground for rubbish; however since Christmas the States Public Works team have been cleaning the site. Work is needed to build a retaining fence around the bunker which will help divert rainwater. Volunteers will also be helping in making the inside safe for visitors.



Visit Alderney are working with the Alderney Society and the Alderney Wildlife Trust on the project. School children have helped paint inside and the hope is for the bunker to be open to public by Easter.

SOURCE: *ITV News*, 9 March 2019.

### German nursery sinking into WWII bunker

A small German town is suing the government after its nursery began to sink into a bunker built by the Nazis. The mayor of Nalbach, a mining area eight miles from the French border, discovered the lost stretch of the old defensive Siegfried Line by accident when he ordered a batch of soil tests before a routine renovation of the St Peter and St Paul kindergarten.

The bunker, which was sealed at the end of the Second World War, had been undisturbed for so long that stalactites had formed on its ceiling. Several parts were in immediate danger of collapsing and bringing the building above crashing down.

The federal government has refused to contribute to the millions of euros needed for repairs because it says the claim is nearly 60 years too late. It is only liable for claims of war-related structural damage filed before 1959. The town argues that the government is to blame because the official maps bore no trace of the bunker.



*Plan of the bunker*

Between 1938 and 1940 the Germans built an extensive network of fortifications along their western frontier, running 400 miles from Cleves in the north to the Swiss border in the south. As part of the strategically important ‘Red Zone’. The section of the Siegfried Line between Aachen and Basel, Nalbach was riddled with a tunnel complex that was large enough to house a thousand soldiers.

In places the earth beneath the nursery’s floorboards had sunk by almost two metres. The 110 children who attended have been moved to a smaller building in a neighbouring village.

SOURCE: *The Times*, 2 January 2019.

### No-deal Brexit bunker at MoD

A nuclear bunker under the Ministry of Defence’s London HQ has been activated amid mounting fears of a Brexit emergency, it has emerged. Officials have moved into the Whitehall base, from where they will be able to direct the 3,500 troops put on standby to tackle disruption if there is a no-deal outcome.

The bunker is the hub of *Operation Redfold*, which could see the troops deployed to handle rioting or to ensure that food gets through ports. The preparations were revealed as it emerged that the expected delay to Brexit, originally scheduled for next Friday, might be for just a few weeks.



The occupation of the bunker was revealed by Sky News' foreign affairs editor Deborah Haynes, who tweeted: 'The Redfold mission is the military dimension of cross-Whitehall no-deal contingency preparations, called *Operation Yellowhammer 2*.' The nuclear bunker was previously used as a hub to coordinate flood relief efforts as well as security and logistics for the London 2012 Olympics.

SOURCE: *Metro*, 22 March 2019.

### **WWII V2 rocket underground in Germany to underground near Sittingbourne in Kent**

Paul W. Sowan reports:

Your scribe was lucky to reach the age of five! On 15 November 1944 he was just missed by a V1 'doodlebug' which went over the roof of his family home to destroy several houses and kill three people two streets away. And on 29 December the same year a V2 rocket fell into a chalk pit about 100 yards away, destroying a single house and killing another three persons. He slept through both events in the family's Morrison shelter, so has no memory of the explosions.

Our next-door neighbours had a chunk of sheet metal in their garden claimed to be a part of the V2, although the claim must be doubted as the authorities were anxious to collect as many fragments of the terror weapon as possible to understand its constructional features. The infants' school your scribe should have attended in 1945 was also destroyed by enemy action before he was due to commence there. Much later in life he has visited, with other Subterranea Britannica members, the tunnels at Nordhausen where the V2 rockets were made, the tunnels at Wizernes in France where they were stored, and sundry sites in France where V1 and V2 weapons were launched. The Kent Archaeological Society has recently published a detailed and most interesting study of the site where one of Germany's 1119 V2 rockets landed near Sittingbourne on 15 February 1945. It had been launched in the Netherlands, reached an altitude of about 50 miles, and impacted the field at about three times the speed of sound, forming a crater 57 feet (17.37 metres) across and 18 feet (5.48 metres) deep.

On account of its speed, the one-tonne warhead did not explode on impact, but at a depth of 5.5 metres in the bed of clay, gravel and sand overlying Chalk. Fortunately, the resulting crater was in an arable field, around 250 metres from the nearest buildings, with no reported casualties. The site was identified by magnetometer survey, and the edge of the crater confirmed by archaeological trial trenching which led to the discovery that the metal detected had been agricultural and domestic rubbish dumped in the hole, not fragments of the rocket.

Searches for rocket fragments at the time proved disappointing. The designers of the V2 presumably hoped the rocket would explode on impact, maximising the range and amount of blast damage. The impact speed and the soft rock where the rocket landed ensured the detonation was at a point sufficiently deep for significant

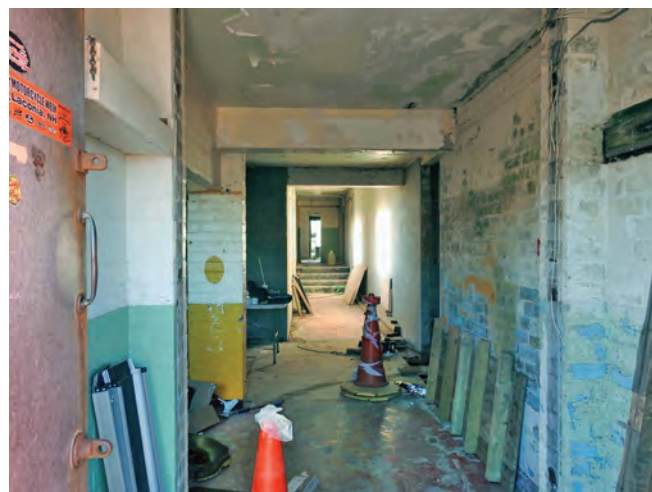
identifiable parts of the weapon to be preserved by burial in the chalk around four metres below ground level.

The V1 weapons were, in terms of value for German money, a 'better buy' from the military point of view than the V2. Both had psychological value in alarming the target populations. Whereas the V1 could be heard approaching, the first anybody knew of a V2 was the explosion. The supersonic approach speed meant you heard the thing coming only after it had exploded. The report is accompanied by a detailed consideration of the identifiable rocket fragments.

SOURCE: WELCH, Colin, 2018, Lynsted V2 rocket excavation. *Newsletter: Kent Archaeological Society* 110, 6–9.

### **New use for Snaefell R11 ROTOR building**

The former CHEL R11 ROTOR Radar station at Bungalow on the lower slopes of Snaefell on the Isle of Man has been unoccupied since the closure of Murray's Motorcycle Museum in 2006. On 18 February 2019 a planning application was submitted for change of use from a museum to provide cafe and retail including a brewery and bakery.



*Spine corridor in the R11 during refurbishment.*

*Photo Chris Corkish*

The plans for the refurbishment show the removal of some of the internal walls but externally the building will remain largely unaltered. Sub Brit member Chris Corkish was allowed access during the early stages of renovation.

SOURCE: Chris Corkish.

### **Archaeological excavations at Fort Amherst, near Chatham, Kent**

Major fortifications at and around Chatham date from 1667 when a Dutch naval assault inflicted 'humiliating damage' to moored British ships in the lower Medway. The defensive works were multiplied and extended, and in military use, into the 20th century. One of these, Fort Amherst, remained in Ministry of Defence occupation until bought by the Fort Amherst and Lines Trust in 1980. The fort has significant subterranean elements, and is now regularly open to the public. The complex has been described by English Heritage / Historic England as 'the most complete Napoleonic fortification in Britain'.



The cited report confirms the location of long-demolished structures including an early extramural latrines block, and some WWII foxholes and gun emplacements. Large numbers of spent black cartridges recovered have been identified as relics of modern but apparently not recorded military re-enactment exercises.

SOURCE: HORNSBY, Roger, and Richard TAYLOR, 2018, Excavations at Fort Amherst. *Newsletter Kent Archaeological Society* 110, 25–31.

## NEWS – MINES AND MINING

### NAMHO Conference 4 – 8 July 2019

The National Association of Mining History Organisations, of which Subterranea Britannica is a member, is to hold its 2019 Conference at Llanafan, Ceredigion, in mid-Wales, hosted this year by the Cambrian Mines Trust. The usual format for these conferences includes a choice of indoor lectures and underground and surface guided visits.

There are associated displays and, naturally, social gatherings and a bar. It is generally the case that those attending find their own overnight accommodation locally. Many bring their own camping gear, or caravans. There is a suitable field for tents with an adjoining permanent toilet block, and a ‘portable four-person shower’ is promised. Bookings can be made now on [http://cambrianmines.co.uk/NAMHO\\_2019/index.html](http://cambrianmines.co.uk/NAMHO_2019/index.html) Details will be found of charges for camping (£12 per night), lectures, trips, a barbecue or a dinner, &c, with ‘early bird’ rates for bookings made before 30 April.

### Reigate Caves days in 2019

The Wealden Cave and Mine Society (WCMS) offers public guided underground tours in central Reigate, Surrey, on five Saturdays each year, for which a small charge is asked. These have proved to be remarkably popular in recent years. There are numerous rock-cut locations in and around the town, and those visitable include a possibly Norman ‘cave’ under the site of the former 12th-century castle, 18th-century abandoned pillar-and-stall mines for silver sand for glass-making, wine and beer cellars and vaults, and England’s oldest surviving road tunnel – now a pedestrianised public right of way at all hours.



Tunnel Road West. Photo Nick Catford

The three contrasting locations are the so-called ‘Barons’ Cave’ in the Castle Grounds park and the Tunnel Road East and West ‘Caves’. All three are owned by Reigate & Banstead Borough Council, WCMS being allowed to open them to the public by license. At Tunnel Road West the Society is allowed to admit the public on the five Saturdays each year by the occupying rifle club.

There is level access to the electrically lit Tunnel Road caves from Tunnel Road, with just a few steps in places. And in Tunnel Road East there are evolving displays featuring the geology, local mineral industries including other nearby underground sites; beer and wine storage cellars, the wartime uses of the ‘caves’ as air-raid shelters; and the Cold War. The Barons’ Cave has short flights of shallow steps in places, and lighting is by hand-held lanterns lent to visitors.

The 2019 Cave Days will be on Saturdays 11 May, 8 June, 13 July, 10 August and 14 September. All the volunteer guides are WCMS members, and can tell visitors about other underground places in east Surrey, not publicly open, but to which guided visits can usually be arranged.

SOURCE: Paul W. Sowan.

### Reports of a building-stone quarry, a marble mine and a lead mine, Derbyshire

Some years ago one might have been forgiven for believing that sites of subterranean interest in the Peak District are almost exclusively lead mines. The picture has been widened by the late Trevor Ford and by the current prodigious output of published work by John Barnatt.

Three recently published reports present the results of archaeological surveying and interpretation of 160 metres of underground sandstone quarry tunnels of 19th-century date in Staffordshire; two underground quarries at Ashford for black marble for use as a decorative stone; and a lead mine in Lathkill Dale.

SOURCES: BARNATT, John, and Terry WORTHINGTON, 2018, The Daisy Knowl underground stone quarry, Longnor, Staffordshire. *Mining History* 20 (3), 1–11 [SK 0824 6519]; BARNATT, John, and Terry WORTHINGTON, 2018, Mandale Mine, Lathkill Dale, Over Haddon, Derbyshire: survey and interpretation. *Mining History* 20 (3), 45–78 [SK 196 661]; and BARNATT, John, and Terry WORTHINGTON, 2018, Quarrying black marble at Ashford: a detailed archaeological survey of Rookery and Arroch mines, with an outline history of extraction. *Mining History* 20 (3), 13–44 [SK 191697 and SK 191694]

### Degradation of ancient underground quarry tunnels at Caestert, Belgium

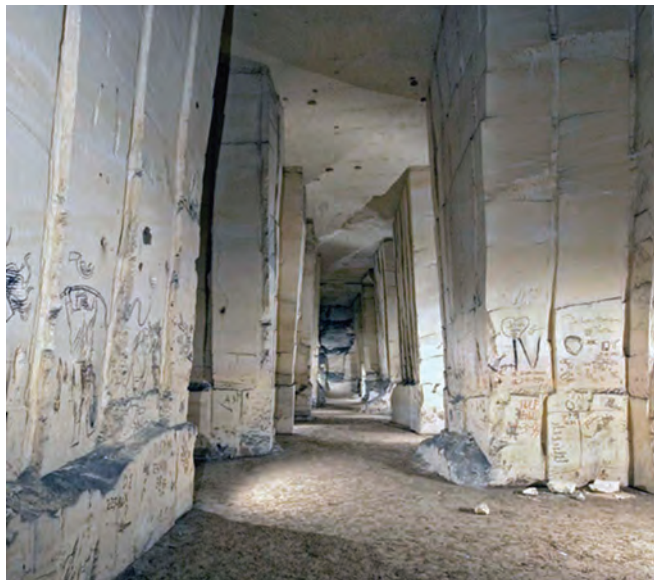
Immediately to the southwest of the Dutch city of Maastricht, in the south of the Netherlands, lies Sint Pietersberg, a ridge of limestone of Upper Cretaceous age which extends across the border into Belgium. The ridge lies between the river Maas and its small tributary the Jeker.





The northern end of the ridge, in the suburbs of Maastricht, is dominated above ground by Fort St Peter and, underground, by an extensive system of a tunnelled building-stone quarry, currently operated as a tourist attraction. Further south, the quarry tunnels have been quarried away by opencast working for a large cement factory. What remains of the original ground surface at St Pietersberg is much appreciated public open space and a nature reserve.

The Belgian border lies just south of the cement works, where further underground quarry tunnels survive under the Caestert plateau. These quarries are some centuries old, and pre-date the present boundary between Belgium and the Netherlands which dates only from 1839. The quarry tunnels, both sides of the border, are of impressive dimensions, with floor to ceiling heights of ten metres or more in places. And as the relatively soft limestone was extracted largely as blocks removed by sawing, the resulting smooth quarry walls have long been used for writings and drawings from centuries ago to modern times. Four distinct underground quarries are named in the



cited report, which consists almost exclusively of colour photographs illustrating the historically important graffiti and highly regrettable instances of deliberate defacement by crude modern scribbling. Although under British law these quarries would undoubtedly qualify for Scheduled Ancient Monument status, they appear not to have adequate official recognition or protection under Belgian law, and have unrestricted access.

The publishing body, the working group for underground quarry research in the Belgian administrative district of Riemst, works in collaboration with other such groups both sides of the international boundary. It is a complication that the Dutch and French language boundary runs through the quarries.

SOURCE: WERKGROEP GROEVENONDERZOEK RIEMST, 2018, *Dégradation du patrimoine et atteinte au paysage souterrain dans les carrières sous le plateau de Caster / Beschadiging van het erfgoed ende aantasting van*

*het onderaardse landschap in de groeven onder het plateau van Caster*. Werkgroep Groevenonderzoek Reimst: 94pp.

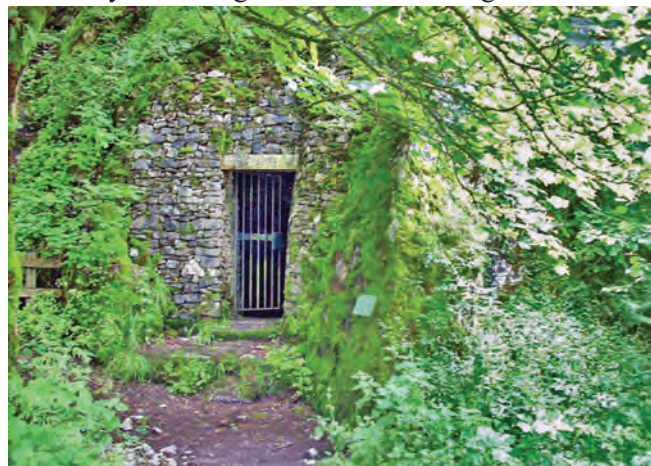
### **Conservation work at access adit to Ecton copper mine, Staffordshire**

Ecton mine, on the western fringes of the Peak District, was once one of the most important sources of copper ore in the 18th century, during which time an estimated 100,000 tons was raised on behalf of the Duke of Devonshire who was lucky enough to own it. It is believed that copper was mined here from as early as the Bronze Age.

The importance of this mine, now in the care of the Ecton Mine Educational Trust ([www.ectonmine.org](http://www.ectonmine.org)), is recognised by its Scheduled Ancient Monument and Site of Special Scientific Interest status.

The lower depths of the mine have long been flooded, but obviously the higher levels were worked first and are oldest and archaeologically of greatest importance. Mining below the natural groundwater level became feasible only with the development of stationary steam winding engines used to pump water out.

Recent conservation work has stabilised ten metres of an access adit, where bulging dry-stone side walls and a visually unsettling stone arched ceiling have been of



concern. Recently secured external funding has made possible remedial work in this area by Derbyshire Geotechnical Ltd assisted by two cavers from the Northern Dales, one of whom is a registered master-craftsman stonemason. The shallow adit was unroofed, the side walls rebuilt, and the adit roof reinstated, using existing and local stone. The work of course required Scheduled Ancient Monument Consent, and was properly supervised by an archaeologist with a ‘watching brief’.

SOURCE: BROOKS, Simon, 2018, Ecton mine restoration. *Descent* 265, page 12.

### **Through trip from Cwmorthin Old Vein to Oakeley Back Vein slate ‘mines’, North Wales**

The two slate ‘mines’ or underground slate quarries Cwmorthin and Oakeley, at first worked by different companies, were linked underground in or about 1930, Cwmorthin having been inactive since 1900 but brought back into production by the Oakeley company.



A recently published account of a through trip from Cwmorthin to Oakeley describes, *inter alia*, the industrial archaeology of a six-km route through the linked workings, of an estimated 102 kilometres of total passage length. Part of Cwmorthin has commercially organised ‘adventure’ trips, *Go Below* and the *Hero Extreme Route*; and has been fitted with climbing aids and zip-wires across some spectacular voids. The described visit was not one of the commercially led trips, so departs from the commercial route.



*Cwmorthin adit*

Much of industrial archaeological interest remains and is mentioned, including machinery, tools, powder horns, detonator boxes, pump gear, rubble carts, and boiler and ‘compressor room’. The visit described demands caving gear and expertise and stamina. The linked quarries have within them “the deepest publicly accessible point in the UK” at 1,200 feet below the surface.

SOURCE: CHINNER, Matt, 2018, Cwmorthin Old Vein & Oakley Back Vein. *Newsletter Chelsea Speleological Society* 60 (7/8/9), 60–61.

### **Lochaline sand mine, west Scotland**

Before World War I glass-sand for high-quality optical glass for binoculars, periscopes, telescopes and the like was imported from Belgium and France. When this became impossible, a nationwide search was made for high-quality sand for the same purposes, as a result of which deposits of high-quality quartz sand were identified and in some cases exploited. There was a similar exercise during World War II.



*Lochaline mine in 1960*

Britain’s most remote sand mine, at Lochaline on the west coast of Scotland, opposite the Isle of Mull, was still being worked in 2018 ([www.lochalinequartzsand.co.uk](http://www.lochalinequartzsand.co.uk)). It was possibly established in or at least by 1940 when a short two-foot-gauge railway was laid from the mine to the nearby harbour, from where the sand is currently shipped to a glass-works at Runcorn. The railway was apparently replaced by lorries in or about 1962, and the mine closed temporarily in 2008, but was brought back into production in 2012.

SOURCE: BARNES, ROBIN, 2018, Lochaline sand mine. *Archive* 100, page 48.

### **Five decades of settlement and subsidence, UK**

One of the small band of the United Kingdom’s acknowledged experts on ground subsidence has reviewed this topic in the light of case studies and developments in understanding since the 1960s. Half a century ago interest in and understanding of settlement and subsidence was primarily focused on the coal-mining districts of the British Isles.

Since then, the very widespread if sporadic incidences of the effects of mining for other minerals than coal has developed. These miscellaneous mining events have been mostly in underground exploitation at shallow depths of stratified rock beds, rather than in the more limited areas where metallic ore minerals have been mined from steeply dipping veins, as for example in Devon and Cornwall.

The scope of the cited paper is effectively a review of contributions published in the *Quarterly Journal of Engineering Geology and Hydrogeology* published by the Geological Society of London between 1967 and 2016. Other and later relevant publications have not been covered in this detailed review.

Coal extraction naturally accounts for much of the text. But there is full recognition of other mining enterprises. The salt mining district of Cheshire, whether by pillar and stall working or by solution mining, has suffered numerous and extensive areas of subsidence. Controlled solution mining in dry rock salt is now adopted and avoids problems.

Due attention is given to miscellaneous mining operations well outside the traditional deep mining regions, such as for building-stone, chalk, gypsum, and limestone. Water has often caused or at least accelerated mining subsidence, either by solution, or by softening or weakening rock. Leaking water mains and alterations to surface water run-off patterns has often been problematic. Finally, settlement and subsidence is not always caused by mined or natural cavities. Heavy structures erected on compressible or potentially mobile rock for example may also be at risk.

SOURCE: EDMONDS, Clive, 2018, Five decades of settlement and subsidence. *Quarterly Journal of Engineering Geology and Hydrogeology* 51 (4), 403–416.



[NOTE: Your scribe adds that Arup Geotechnics' *Review of Mining Instability in Great Britain* published for the Department of the Environment in the 1990s concluded that subterranean mining of one sort or another has been carried on in every English and Welsh county and every Scottish region apart from the Outer Hebrides.]

### **Russian coal mines and mining at Svalbard (Spitzbergen)**

The island of Svalbard, a detached part of Norway in the Arctic, has long had a population, mostly of Russians, on account of the several coal mines operated there in the inhospitable (very cold) environment where there is always a risk of attack by presumably hungry polar bears. There are two very small towns, but today only a single mine (of at least eight) remains working.

The two small towns (Pyramiden and Longyearbyen) are now developing as tourist destinations. The coal mined here is geologically much younger than most British coal, having formed in Jurassic rather than Carboniferous times. Coal of Jurassic age was still being raised from a deep mine, now closed, at Brora on the east coast of northern Scotland in the 1960s.



*Infrastructure sits idle at the coal mine at Longyearbyen*

A recent visitor has reported that at Pyramiden the Russians offer guided tours, led by a man with a rifle to deter bears. Understandably, visitors are encouraged not to wander off, and there seemed to be no opportunity to get closer to the mine installations and drift entrances.

At Longyearbyen, where one mine remains in operation, there is a museum and a church and a supermarket and tourist shops (and presumably an hotel), and standing near the centre a statue of a coal-miner and a stuffed polar bear. All the mines were once linked to the harbour by a system of aerial ropeways on timber pylons, of which only the pylons remain as lorries are now used. This being Norway, one could guess that a visit would not be at 'budget' prices!

SOURCE: CHATURN, Axel, 2018, A visit to Spitsbergen. *Newsletter: Peak District Mines Historical Society* 169, page 11.

### **New deep coal mine in Cumbria**

Britain's first new deep coal mine in 30 years has

been given the go-ahead by Cumbria county council, sparking protests from climate change campaigners that the decision would harm the UK's efforts to reduce CO2 emissions. The £165m Woodhouse colliery was backed by Labour, Conservative and Liberal Democrat councillors, who said it would bring vital jobs to the area.

The developer West Cumbria Mining Limited said the site, along the coast from Whitehaven, would process 2.5m tonnes of coking coal a year for the UK and European steel industry, replacing imports from the US, Canada, Russia and Colombia. To mitigate some of the impact of the plant on the environment, the owners have agreed a deal for a 50-megawatt solar farm nearby to provide about a third of the project's energy needs.

The mine is due to begin production in about two years' time, subject to environmental certificates, and is expected to employ 500 people, with an estimated 2,000 more jobs created in its supply chain.

SOURCE: *The Guardian*, 19 March 2019.

## **NEWS - MISCELLANEOUS**

### **Proposed subterranean home at Holland Park, west London**

Kensington & Chelsea Council has been asked to grant planning permission for an almost entirely subterranean two-storey house in 'one of London's most exclusive streets'. From a bronze anodised aluminium translucent glass cube entrance pavilion, access would be to domestic rooms, a swimming pool, and four small courtyard gardens. The site, described as currently 'derelict land', was purchased for £880,000 in 2011. Some local residents favour the proposal while others object to it.

SOURCE: SHEPPARD, Owen, 2019. Model Edie's architect mother unveils plans for 'unique' underground home. *Evening Standard*, 17 January 2019, page 4.

### **Complex upgrade work at Bank underground station, London**

A significant milestone has been reached in the modernisation works at Bank station. The major breakthrough saw the first link made between newly constructed Northern line Tube tunnels and a new entrance on Cannon Street. It will make further construction work easier, helping to ensure the important upgrade work is completed by 2022.

Bank and Monument stations are interlinked, with a complex network of tunnels underground. Engineering and construction teams have been working at two separate sites, 24 hours a day, since 2016, to excavate more than 1000m of tunnels and build a new station entrance. The tunnels have been excavated using two diggers, as the confined space prevented the use of a tunnel boring machine.

In some instances, tunnelling has been carried out by hand, using traditional mining techniques. A new southbound tunnel has been constructed to convert the existing tunnel into a customer concourse, and a new

entrance to the Waterloo & City line on Walbrook is already easing congestion for passengers. The upgrade project will deliver twelve new escalators, with a new link connecting both the Central and Northern lines with the DLR.

SOURCE: *Metro*, 20 March 2019.

### **Proposed two-storey basement below Kensington Palace orangery, London**

There have been objections to proposals for the construction of a two-storey basement below the 323-year-old Grade I listed orangery which stands in the grounds of Kensington Palace. The purpose of the basement would be accommodation for Historic Royal Palaces staff and for the Royal Ceremonial Dress Collection.

The orangery, designed by Sir Christopher Wren, was built to allow the cultivation of exotic fruit trees such as oranges through English winters. Like other examples, the Kensington orangery has an impressive range of large south-facing windows to admit as much sunlight and warmth as possible. The proposal, by Historic Royal Palaces, has been opposed by local residents on the grounds that construction traffic would pose danger to others and be environmentally intrusive.

SOURCE: SHEPPARD, Owen, 2018, Palace locals: we're facing years of disruption. *Evening Standard*, 9 August 2018, page 12.

### **148-foot deep dive in Poland to include underwater viewing tunnel**

The world's deepest swimming pool is set to open in Poland, with a depth of 45 metres (148 feet). DeepSpot will open its doors to the public in autumn 2019 in the central Polish town of Mszczonów, about 40 kilometres from the capital Warsaw.



*Artist's impression showing the pool and the viewing underwater tunnel*

It will be accessible to everyone, not only scuba divers, and will include an underwater tunnel, hotel rooms overlooking the pool, as well as restaurants and conference rooms. The Blue Abyss is intended to be a deep sea and space research, training and test facility, whose primary function is to enable extreme environment development – both human and robotic.

SOURCE: *MailOnline*, 7 March 2019.

### **Proposal for a successor to the Large Hadron Collider at CERN**

Cern has published its ideas for a £20bn successor to the Large Hadron Collider. The Geneva-based particle-physics research centre is proposing an accelerator that is almost four times longer and ten times more powerful. The aim is to have the FCC hunting for new subatomic particles by 2050.



*Artist's impression of what the FCC beam will look like*

Cern's Director-General, Prof. Fabiola Gianotti, described the proposal as "a remarkable accomplishment" adding, "It shows the tremendous potential of the FCC to improve our knowledge of fundamental physics and to advance many technologies with a broad impact on society". Cern's plans have been submitted in a conceptual design report. These will be considered by an international panel of particle physicists, along with other submissions, as they draw up a new European strategy for particle physics for publication in 2020.

SOURCE: *BBC News*, 15 January 2019.

### **Modern underground works in Hong Kong, China**

Much has happened in Hong Kong since the territory returned to Chinese rule in 1997. Hong Kong has an area of 1,100 square kilometres and supports a population of 7.3 million persons. Seventy percent of the territory could be described as mountainous, largely composed of igneous rocks. The steeply sloping land is largely vegetated, and the urban areas are densely populated with most people living in high-rise apartment blocks.

The territory consists of the main Hong Kong Island, smaller islands, and a part of the Chinese mainland. Not surprisingly, therefore, rail and road tunnels have had an important role. Some 48 kilometres of railway tunnels have been driven in ten years, along with subsurface passenger stations. Other underground infrastructure includes elements of the water supply and sewage disposal systems and, less expected, a subterranean explosives storage facility.

Within the Hong Kong Specialist Administrative Region within China, with water separating several islands and the mainland New Territories, road and rail tunnels have of course been particularly important. These include such works as the Deep Bay Link; Hong Kong to Macau road bridge (including the world's longest and deepest underwater tunnel); and the Liantang / Heung Yuen Wai

crossing and connection with the mainland express rail link (Hong King High Speed Rail Project).



*Hong Kong to Macau road bridge and tunnel*

Other local lines on the main island have also included underground lines and subsurface stations. The cited paper includes a photographic record of some of the major underground developments from the period 2006 to 2016. SOURCE: KOOR, N.P., 2018, What lies beneath? A decade of underground construction in Hong Kong. *Quarterly of Engineering Geology and Hydrogeology* 51 (3), 301–310.

## NEWS – PUBLICATIONS

### Reviews by Paul Sowan unless stated

**NOTE:** Subterranea Britannica does not generally receive free review copies of relevant books from publishers (although these would of course be acceptable). Most titles noted here have been purchased by Paul Sowan for his own collection. Review copies should be sent to him at 96A Brighton Road, South Croydon, CR2 6AD.

#### **Descent – half a century of publication**

*Descent* is a magazine primarily catering for the interests of British cavers, published every two months. The first monochrome issue appeared in January 1969, and it is now published in full colour. Almost if not quite every issue contains articles and news items dealing with sites and events of interest to members of Subterranea Britannica, that is to say underground spaces made or used by man, as well as natural caves of course.

The magazine has been produced by a very small team (Chris Howes and Judith Calford) since issue 84 in 1988. The publishers since 1998 have been Wild Places Publishing. The latest issue received, #166, is that for February/March 2019. For further details see [www.wildplaces.co.uk](http://www.wildplaces.co.uk).

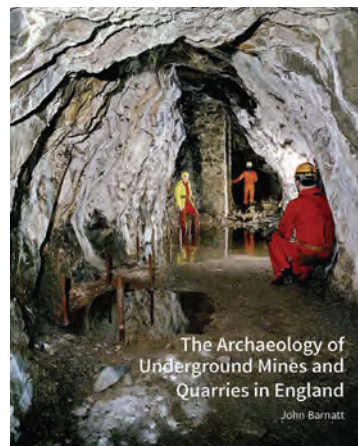
#### **Archaeology of underground mines and quarries in England**

DETAILS: BARNATT, John, 2019, *The archaeology of underground mines and quarries in England*. London: Historic England: 136pp [ISBN 9781-84802-381-9] [£30 inc p/p]

This recently published volume partly grew out of the NAMHO (National Association of Mining History Organisations) Research Framework for the Archaeology

of Extractive Industries in England. It provides an accessible, comprehensive and illustrated guide to the remains beneath our feet that help tell the story of mining over the millennia.

Its author, John Barnatt, spent thirty years as Senior Survey Archaeologist for the Peak District National Park. Most of the photos are by the late Paul Deakin and the book is dedicated to Jon Humble, whose work at English Heritage did much to promote the importance of subterranean remains until his untimely death in 2015.



The volume is comprised of two main sections – part I covers the nature of underground products and their regional occurrence. Part II covers archaeological features including those associated with extraction, transportation and infrastructure. The book also includes useful appendices including a glossary of terms, extensive footnotes, a bibliography and organisations to contact for more information.

Over fifty different products exploited from underground sources are identified: these range from metals to minerals and from fuels to building materials. The book also documents over one hundred types of archaeological features, from micro items such as tool marks and graffiti through to macro features like tramways and drainage systems.

The work has much to commend it and it pleasingly includes Subterranea Britannica (unfortunately misspelt on one occasion) as both a source and a destination for more information. The index is very helpful but not fully comprehensive (for example, Boulby Potash Mine is mentioned and illustrated but neither Boulby nor Potash appear in the index).

One personal criticism is that too many of the photographs are over-populated with explorers in full caving gear. Whilst these undoubtedly add scale, it seems to me that this extension of pot-holing photographic convention is intrusive. The cover photo alone features three explorers in shot. Reflecting the author's particular expertise, mines around the Peak District and Derbyshire are perhaps over-represented but this is acknowledged in the introduction. It is a pity that the range doesn't extend across the whole of the United Kingdom but this is understandable given Historic England's remit.



The volume is thoroughly recommended to all enthusiasts whose interests include mining history and exploration. At £30 it is quite steep for 144 pages but a discount is available for Sub Brit members (see panel). Alternatively, why not request a copy via your local public library which should boost sales and provide a valuable local resource for other enthusiasts.

**Martin Dixon**

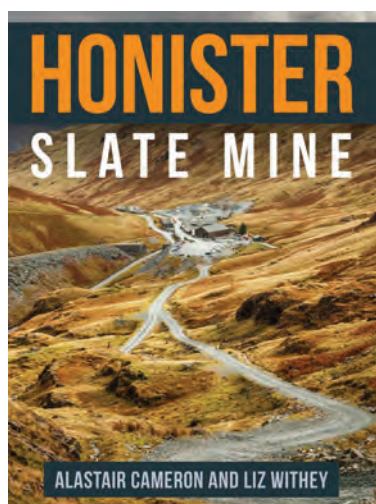
**Sub Brit Members' Discount**

**on *The Archaeology of Underground Mines and Quarries in England***

Readers of *Subterranea* can receive a 20% discount and free p&p by entering discount code **AUMQ19** on the basket page of the Historic England online bookshop: <https://retail.historicenglandservices.org.uk/index.html>

**Honister slate mine, Cumbria**

DETAILS: CAMERON, Alastair, and Liz WITHEY, 2018, *Honister slate mine*. Stroud: Amberley Publishing: 96pp [ISBN 9781-4456-7199-4] £14.99.



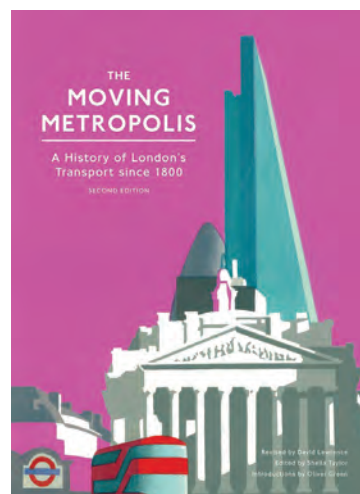
Members of *Subterranea Britannica* fortunate enough to visit Honister a few years ago will recall a dramatic location and a fascinating underground visit. Slate has been worked opencast here for some centuries, and also underground from the sixteenth century. Access to the entrances to the Honister and Kimberley mines, where three seams of slate have been extracted, has always been challenging and the roadways, counterbalance inclines and aerial ropeways installed are all chronicled and illustrated.

Commercial mining by McAlpine's ceased in the 1980s when it was realised that economic extraction on a large scale would have to be by opencast working. In 1997 the lease was purchased by the late Mark Weir, a local man, who recommenced mining on a smaller scale, alongside operation as a tourist attraction.

Sadly, Mark Weir died in a helicopter accident on 8 March 2011. Fortunately his family has elected to continue the mine and the visitor attraction. This latest phase of the mine's life and development is chronicled in some detail. The book is exceptionally well illustrated with both historical and modern photographs.

**The moving Metropolis: a history of London's transport since 1800**

DETAILS: LAWRENCE, David, 2015, *The moving Metropolis: a history of London's transport since 1800*. Lawrence King Publishing/London Transport Museum: 448pp [ISBN 9781-78067-671-5] £24.95 but with a 75 percent discount at the LT Museum.



This substantial volume is a revised and updated edition of a work first published in 2001. It is profusely illustrated, with at least one image from the LTM collection on almost every page, the text consisting mainly of extended captions.

The scope includes all forms of public road transport (buses, trams, trolleybuses and taxis), surface and underground railways and river bus services). Even the temporary demonstration 'pneumatic' railway in the grounds of the Crystal Palace is noted briefly. All aspects of these are included from vehicles, routes, bus stops, and station to route maps and posters and ticketing systems. There is a liberal provision of historic illustrations dated from 1798 onwards. Modern developments up to 2014 include Crossrail (the Elizabeth Line) currently being developed, Croydon Tramlink, the Docklands Light Railway, modern underground railway extensions, and London Overground. There is a short bibliography and a seven-page index. Whilst no one aspect of this long and complex story is pursued in depth, the volume provides a useful overview of developments and their dates.

**Accidents in British railway tunnels**

DETAILS: MATHESON, Rosa, 2017, *Terror in the tunnels: Britain's dangerous railway history*. Stroud: The History Press: 192pp [ISBN 9780-7509-6996-3]

This book presents a wealth of information from widely scattered sources concerning accidents during the construction or operation of 19th-century railway tunnels,



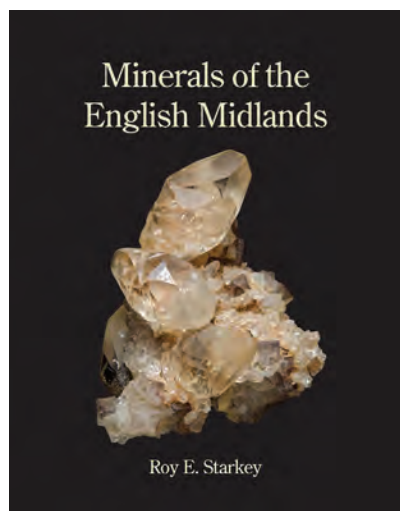
from the 1830s to the 1890s. Had its scope usefully been widened to include road tunnels, the collapse and abandonment in 1812 of the Highgate tunnel might have been included: there were of course remarkably few road tunnels before the driving of the Blackwall Tunnel in 1892–97.

The Brunels' celebrated Thames Tunnel is not mentioned, properly enough, as it was intended at the outset to be a road tunnel, and saw no trains until it was converted for railway use in the 1860s. On the other hand, a book treating also of the mostly earlier and poorly documented British canal tunnels would have been more challenging to research.

Tunnel construction problems included rock falls, groundwater flooding, and men falling down the vertical shafts made primarily for the removal of excavated spoil. Operational problems, primarily collisions, largely depended on inadequate signalling arrangements. Primary sources cited are from the 1830s onwards and include a wealth of reports from provincial newspapers now so much more accessible via the internet. Secondary sources up to 2014 are also cited. The inclusion of a good index would have greatly improved this nevertheless most interesting and useful book.

#### **Minerals of the English Midlands**

DETAILS: STARKEY, Roy E., 2018, *Minerals of the English Midlands*. British Mineralogy Publications: 426pp [ISBN 9780-9930182-2-0 (hb) /ISBN 9780-9930182-3-7 (sb)].



The UK minerals industry in modern times is dominated by the production of aggregate (sand and gravel) largely for making concrete, the lime industry, and the brick and tiles industries. Historically, deep-mined coal dominated (we still have opencast coal extraction but now no major deep mines).

The term minerals as used in this book is to be understood in the more restricted geological sense of naturally occurring more or less closely defined chemical compounds (or more rarely elements), especially those occurring as geometrically precise crystal shapes. The products of stone quarries and gravel pits, for example,

are largely outside the scope of this book, the illustrations in which are predominantly of attractive naturally occurring crystals.

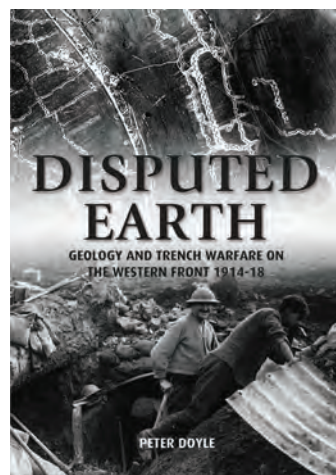
The English Midlands, for the purposes of this book, comprise thirteen counties. The bulk of the text forms a valuable gazetteer of mine (and some quarry) sites in each of these districts. There are useful if short accounts of localities which are 'not significant mineral localities in their own right', such as the limestone mines around Dudley, but which 'warrant a brief mention because of their considerable historical and local interest'. Some sites have been worked for rocks composed largely of crystallised single minerals such as gypsum and rock-salt. Alongside the numerous photographs of mineral specimens there are some featuring surface and subterranean views of mines, with generous representation of historic illustrations of the Cheshire rock-salt mining districts for example. There are also important and interesting accounts of small localised mineral occurrences. The identification of vanadium minerals near Alderley Edge, an interesting story, forms one example of the thoroughness of this survey. The economically important celestine (strontium sulphate) extraction near Bristol is the subject of a well-documented account of a unique British resource.

There are short chapters devoted to 'decorative stones' such as Ashford Black Marble and Blue John, and to historically important mineral collectors and mineral collections in private hands as well as in museums.

Perhaps puzzlingly, for a book essentially devoted to the minerals found in metalliferous mines, the chemical compositions of some of the featured materials are not stated, or are buried in the text. A glossary of mineral names and compositions would have been helpful; mineral occurrences are a feature however of the thorough index in pages 415 to 426.

#### **Geology and trench warfare on the Western Front, 1914–18**

DETAILS: DOYLE, Peter, 2017, *Disputed earth: geology and trench warfare on the Western Front 1914–18*. London: Unicorn Publishing Group: 285pp [ISBN 9781-910500-87-5] £24.



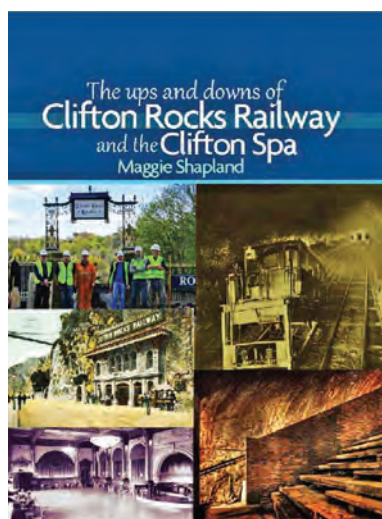
An overall picture and understanding of the genesis and development of the Western Front in Belgium and northern France in WWI is rendered problematic as the area is criss-crossed by so many boundaries. Apart from the international border, there are the Flemish and Walloon linguistic frontiers, the areas held by various army groups, and possibly most importantly the geological boundaries and confusing terminologies.

Geology is important in warfare in connection with such things as water supply, sources of road-surfacing and concrete-making materials, the practicability of making trenches, dug-outs and tunnelling, and ground conditions from the point of view of moving heavy equipment across country. At the start of the war Germany was well in the lead in appreciating such factors. The British, realising the tunnelling and mining activities of the enemy, had to catch up, employing, late in the day, geological expertise. Peter Doyle's book is highly recommended for anyone interested especially in military mining and counter-mining, and subterranean works for shelter and sheltered access. Such works were most easily created in those areas underlain by dry chalk, above the water table.

The numerous illustrations include geological and topographical maps and sections, trench and tunnel maps and plans, and historic and modern photographs from British and German sources. There are comprehensive explanatory notes and references to sources, a glossary of technical terms, a bibliography and a thorough index.

### **Clifton Rocks Railway, Bristol**

DETAILS: SHAPLAND, Maggie, 2017, *The ups and downs of Clifton Rocks Railway and the Clifton Spa: the definitive history*. Bristol Industrial Archaeology Society/Clifton Rocks Railway Trust: 301pp [ISBN 9781-908905-05-5]



This is an astonishing book which, in over 300 pages in a weighty hardback volume, describes a very short (450 yards), steeply inclined, and entirely subterranean railway in Bristol. The journey time from terminus to terminus was 40 seconds. What makes the Clifton Rocks Railway of special interest are its engineering features and the secondary uses to which the tunnel was put

after closure in 1934. The tunnel in which the railway ran accommodated four parallel sets of lines, and was inclined to the horizontal at a gradient of 1 in 2.223.

The railway was made in the years 1891–93 from the former Hotwells spa to a point on Clifton Downs some 200 feet higher. An earlier proposal was for a funicular line open to the air, which would have offered passengers splendid views of the Avon Gorge and Brunel's suspension bridge, but to preserve the limestone rock scenery as it was viewed from all other places, such as the bridge, it was dictated to be blasted through the limestone instead. It linked the once fashionable spa at Hotwells lower station with Clifton Down at the top. The Grand Spa Hotel adjoined the top station.

The opening of Brunel's Suspension Bridge in 1864 saw a resurgence of tourism, accompanied by new transportation opportunities through and near the gorge, such as the Bristol Port Railway & Pier Company's line from Hotwells to Avonmouth, opened in 1865. This had its own conventional single track tunnel between the station at Hotwells and the bridge. It was closed in 1922 and has been replaced by the unpleasant Portway Road the presence of which put the Rocks Railway's lower station out of use on safety grounds.

During World War II the Grand Spa Hotel was occupied by the Air Transport Authority which included BOAC. Various parts of the tunnel, from top to bottom, became a barrage balloon workshop, three air-raid shelters for (1) Air Ministry staff, (2) Clifton residents, and (3) Hotwells residents, and studios for the BBC Home Service. There was also air-raid shelter provision in the former Portway railway tunnel at the river level.

The engineering and operational features of the railway and of the several secondary uses are discussed in some detail, with reference to other cliff railways (mostly open to the sky) at Aberystwyth, Bridgnorth, Hastings, Lynton and Lynmouth, and Matlock Bath.

The great majority of British railway tunnels made in the nineteenth century were built to accommodate one or two tracks, and made with slight gradients towards one or both ends to make them self-draining. The short railway described in great detail in this splendidly produced hardback volume was almost entirely in a remarkably steeply inclined tunnel and had no fewer than four tracks in its single bore. It is suggested that two tracks were reserved for the private use of hotel patrons, the other two for the general public.

After the war the tunnel fell into dereliction, and the lower end additionally showed signs of instability in the rock through which it passed, requiring remedial work. The final two chapters chronicle the heroic work of the team of volunteers who have restored the tunnel and top station to visitable condition.

Subterranea Britannica enjoyed a guided visit during the course of that work. It is recorded that 53 open days have



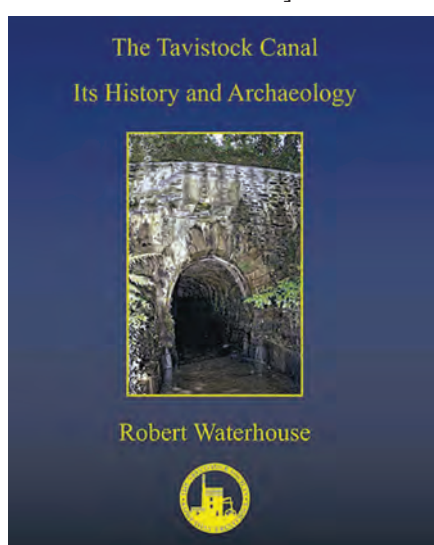


attracted over 31,000 visitors, operated by the Clifton Rocks Railway Company, a charity, which manages the site as a museum. Large numbers of artefacts left by previous occupants have been recorded and illustrated. The work done here recalls the similarly heroic efforts of the Friends of Williamson's Tunnels in Liverpool.

The book is profusely illustrated, with historic and modern images reflecting all phases of the tunnel's location, creation, operation and restoration. There are also on record the memories of, especially, the World War II occupants. The volume concludes with a five-page glossary of specialist terms, supplementary notes, and index.

### **Tavistock Canal and tunnel, Devon**

DETAILS: WATERHOUSE, Robert, 2017, *The Tavistock Canal: its history and archaeology*. Trevithick Society: 536pp [ISBN 9780-9935021-3-2]



The Tavistock Canal was built in the years 1803–17 to link the west Devon town to the minor shipping port at Morwellham, a distance of 4½ miles, one third of which was tunnelled. It was driven with the hope that it would serve existing copper mines, or discover veins of ore worth sinking new ones. The canal was included in the Cornwall and West Devon Mining Landscape World Heritage Site in 2006, and has been in use since 1933 supplying water to a hydro-electric generating station.

For such a short canal, quite isolated from the main canal network of Britain, this is a remarkably large, heavy and expensive book, equally remarkable for the wealth of detail and illustrations, and high quality of its presentation.

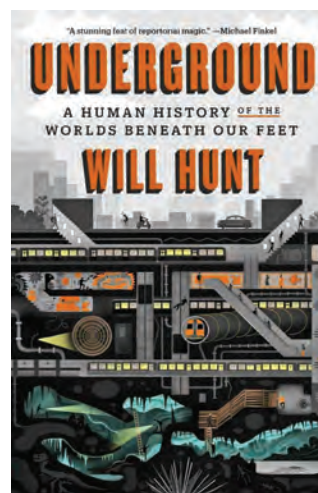
The canal was made for the better transportation of ores, mainly of copper, lead and tin to navigable water at Morwellham and onward shipping to South Wales for smelting. It also conveyed imported coal and limestone, and met local agricultural and industrial transportation needs. Mines had been worked in the locality for some centuries, and the tunnel alignment was planned to intersect eight known ore-bearing lodes and discover hoped-for new ones.

The largely unlined tunnel has no towpath; boats were worked through by pushing wooden poles against the walls. Unusually for a canal, there is a southbound current through the tunnel, calling for additional force to work boats towards Tavistock. The flow was utilised to work canalside and mining machinery and has since 1933 served the small Morwellham hydro-electric power station. It connects at a number of places with shafts to the surface and with mines of which Wheal Crebor was possibly the most successful.

The book also features accounts of the earlier Tamar Manure Canal, and associated feeder leats and launders, plateways and railways, and inclines, and a short branch to limestone workings. Illustrations include maps, plans and mine sections, and above-ground and underground canal and mine features. This magnificently detailed work is accompanied by a six-page bibliography and a nine-page index.

### **Underground: a human history of the worlds beneath our feet**

DETAILS: HUNT, Will, 2019, *Underground: a human history of the worlds beneath our feet*. London: Simon & Schuster UK Ltd: 275pp [ISBN 9781-4711-3957-4 (hardback)] £16.99.



A preliminary glance through this volume brought to mind the substantial volume (over 900 pages) *Underground, or life below the surface* by Thomas Knox published in the USA in 1874, and Stephen Smith's *Underground London*, published in 2004.

Will Hunt, according to an associated publicity flyer, is an 'urban adventurer' which may or may not be subtly different from an 'urban explorer'. This, his first book, is claimed to explore 'the history, science, architecture, and mythology of the subterranean landscape' and in the process reengineers our relationship with the worlds beneath our feet. He has successfully attracted grants and scholarships to fund his travels, and tracked down people worldwide able and willing to take him underground.

His meandering account of visiting underground places in over twenty countries commences with his teenage discovery of an abandoned railway tunnel under his home

in Providence, Rhode Island. His visits to abandoned railway tunnels and to the sewers under New York and Paris, and to the former quarries now ossuaries (catacombs) under the latter were admittedly illegal, whereas access to the very deep (4,850 feet) NASA Astrobiology Institute at the former Homestake gold mine in the Black Hills in South Dakota was with official permission.

There is a brief account of old silver mines at Potosí in Bolivia, and a more extended description of ancient aboriginals' burrowings for red ochre in Western Australia includes an account of associated native folklore. London's story is restricted to the forty years of burrowings under his own home of the late eccentric William Lytton. The 'underground cities' of Cappadocia in Turkey are described in some detail, as is an important prehistoric cave art location in the Pyrenees.

In terms of human experience underground we find accounts of people lost (one man survived for 34 days before being rescued), and experiments on human sensual deprivation in absolute darkness and silence, and on losing track of time. Historic and current military and Cold War sites, and currently active mines, are barely mentioned.

Hunt seems to take as much interest in describing his companions in the dark as the places themselves. Image credits at the end of the book list 261 illustrations. These are of poor quality, lack captions and many are not subterranean views. There is no index. To quote an earlier reviewer of a different work, this book 'will appeal to those who like this sort of thing.'

### **Worldwide miscellany**

DETAILS: KNOX, Thomas W., 1874, *Underground, or life below the surface. Incidents and accidents beyond the light of day; startling adventures in all parts of the world; mines and the mode of working them; under-currents of society; gambling and its horrors; caverns and their mysteries; the dark ways of wickedness; prisons and their secrets*. Hartford: The J.B. Burr Publishing Co. 942 pp.

This is an American work, but the scope of the contents is worldwide. Railway tunnels are considered in Chapter 34; the Mont Cenis railway tunnel in Chapter 35 (which chapter also contains some remarks on the first England–France Channel Tunnel proposal); and the Paris sewers in Chapter 36.

### **Radon, health and natural hazards**

DETAILS: GILLMORE, Gavin K., F.E. PERRIER and R.G.M. CROCKETT (eds), 2018, *Radon, health and natural hazards. Geological Society of London Special Publication 451: (2)+ 244pp* [ISBN 978-1-78620-308-3]

Radon is an odourless and chemically inert gas found in atmospheric air, generated by the radioactive decay of uranium 238. Although most closely associated with igneous rocks such as the granite found in Cornwall and Devon, on account of the uranium content of some of

the constituent minerals of such rocks, it is also found in a wide range of rock types, the minerals in which have ultimately been derived by erosion from older igneous rocks. It is, therefore, present in, for example, sandstones found in southeast England.

Radon tends to concentrate in poorly ventilated confined spaces such as mines, tunnels, and even cellars and building foundations. As radon is radioactive, it poses a small but significant health hazard especially for persons frequenting such places, and is therefore of interest to members of *Subterranea Britannica*. Although this is a professional academic text, it does convey the key information concerning the risk posed by exposure to the gas.

## **NEWS – TUNNELS AND TUNNELLING**

### **New use proposed for York Road LU station, north London**

A suggestion has been made that the disused York Road underground station (closed in 1932) near King's Cross could become home for up to 28 homeless persons aged 18 to 25, made commercially viable by the inclusion of shops and private flats presumably in surface buildings. It is claimed that similar developments throughout London could be a solution to the capital's youth homelessness crisis.



*Photo Ewan Munro*

SOURCE: BENTHAM, Martin, 2018, Architect's bid to let homeless live in disused tube station. *Evening Standard*, 17 October 2018, page 34.

### **Visit to the Milwr mine-drainage tunnel, North Wales**

The Milwr tunnel was made to drain ore-bearing Carboniferous Limestone on the North Wales coast to allow mining for galena (lead ore) at greater depths. Minewater drains northwards to the sea. The cited source describes a visit made by way of the abandoned Rhyd Alyn lead mine, 'a complex of passages with cream coloured mud and some wading through shin height water'.

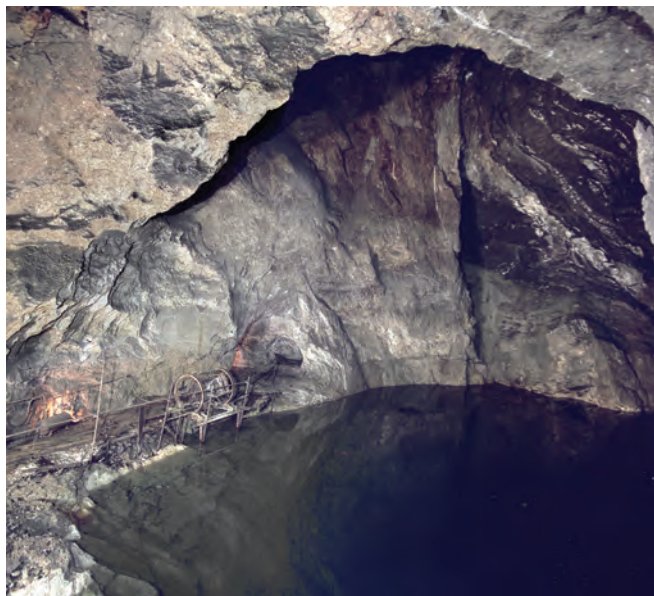
The lead ore was mined from steeply inclined veins, leaving deep near-vertical cavities known as stopes. Worthless rock taken out in the course of exploiting



the veins was stacked on wooden staging below which mining could continue to greater depths. Modern mine explorers need to know that in passages in metalliferous mines in which ore was taken from near-vertical veins they may be walking on waste rock held up by now possibly rotten wooden platforms installed over deep worked-out holes, best not fallen into!

The Milwr tunnel, of necessity, is at some depth, communicating with the deepest mined levels. Here there are numerous (original) fixed ladders 'of varying length and rung spacing'. Some are metal, some wooden and some wooden with metal rungs, and all are 'quite old'! All seemed, reportedly, quite sound, but had anyway safety lines onto which to clip when passing over voids. The tunnel is some ten miles long, and intercepts many more miles of mined tunnels. A relatively recently installed cavers' railway has been installed, and walking along the tunnel means using the sleepers and avoiding a drainage channel in the floor. A four-mile walk led the reporting party to a large natural chamber at Powell's Lode. Mining features noted en route include abandoned mine trucks, explosives storage areas, and 'various other bits and bobs'. There is a former workshop with machinery, charging bays, and tools still *in situ*.

The Powell's Lode cavern is too large to appreciate by the light of caving lamps and contains a sizeable very blue lake which reportedly is deep enough to have held six years' worth of spoil dumping without any discernable difference in the water level.



*The blue lake in Powell's Lode. Note the tippler on the left used for dumping waste material into the lake.*

*Photo Nick Catford*

Also visited were the impressively huge limestone workings, this location having seen limestone mining alongside the galena. Here, too, are abandoned mining relics including mine trucks and a workshop, also rail-mounted Eimco shovels, although the rails here have been removed. The cited source, with accompanying photographs, describes a 9 ½ hours visit. Clearly, an

arduous and challenging, and very interesting and rewarding visit, but not for the faint-hearted.

SOURCE: VOYSEY, Mandy, 2018, Milwr Tunnel. *Newsletter Chelsea Speleological Society* 60 (7/8/9), 69–71.

### **Kilsby tunnel shafts repaired, Northamptonshire**

Kilsby tunnel, on the main London to Birmingham railway line through Northamptonshire, is to the south of Rugby, and was designed by Robert Stephenson (1803–59) for the London & Birmingham Railway. It was constructed between 1834 and 1838 and was, famously, described and illustrated by John Cooke Bourne (1814–96) in his *Drawings of the London and Birmingham Railway*, published in 1839. The interior of the tunnel below one of the two very wide shafts is one of the best-known depictions of early railways.

The single-bore 2433-yard tunnel accommodates two tracks, and continues in main line use after almost 180 years in service. When it was completed it was the longest railway tunnel in the world. This tunnel was made, mainly, from twelve shafts, up which most of the excavated spoil was lifted, and down which most of the bricks for lining, equipment and tools were lowered. The shafts also, of course, were the ways to and from their work for the men digging the tunnel; they were not primarily for ventilation.



Ten of Stephenson's shafts are two to three metres in diameter, but two are very much wider, with a diameter of 18 metres. It was thought at the time that such very wide shafts would be necessary to allow the escape of smoke from the locomotives. However, experience demonstrated that such very large shafts were not needed in railway tunnelling, and no further such wide shafts have been provided since.

In early May 2018 Network Rail organised a press visit to the 58-metre-deep shaft 12 to see work in progress repairing the brick lining. Over a million bricks, weighing 4,000 tons, were used for the construction in the late 1830s. A 'crash deck' was installed just above the overhead electrification wires on the railway, to prevent materials or tools (or people) falling on to the live railway, on which trains continued to run during most of the work, although services had to be suspended during ten weekends while the deck was erected. Access to the

shaft walls was by scaffolding rather than by cradles. Further interruptions for services were necessary for the removal of the crash deck.

SOURCE: SQUIBBS, Jamie, 2018, Kilsby restoration. *Modern Railways* 75 (838), 24–25.

### **Prague to Plzen railway journey improvement with two new long tunnels, Czech Republic**

Journeys by train between Prague and Plzen are now faster as a result of a new 14.1 kilometre stretch of double-track line including two new tunnels bypassing part of the original route. The parallel single-bore tunnels, to the west of Ejpovice, are at 4.15 and 4.17 kilometres the longest on the Czech Republic.

SOURCE: ANON, 2018. Major upgrade for Prague to Plzen line. *Modern Railways* 75 (844), page 97.

### **New undersea subway tunnel in China**

China is building a long tunnel under the sea as part of a £2 billion subway line. Chinese engineers have started to drill a 9,400-ft-long tunnel in the seabed as part of a ‘super’ subway line that will cost £2 billion to build. To dig the sub-surface shaft in northeastern China, workers need to break through rock as deep as 74 ft under the bottom of the Yellow Sea. The land forms of the seabed are extremely complicated and the construction machines will need to cut through a series of huge caves in the seabed.

The largest cave found so far is 95 ft tall. The deepest part of the tunnel is about 164 ft from the surface of the sea, meaning the drilling machine will need to bear enormous water pressure, adding to the difficulties of the project. The tunnel is expected to complete in June 2021. The tunnel connects two stations of the Dalian Metro Line 5, which has 18 stations in total and is expected to complete in 2023.



*Shortly after driving of the tunnel had started*

In order to perform the previously impossible, Chinese engineers developed a mammoth tunnel-boring machine to drill through the seabed. The impressive equipment is 518 ft long with a diameter of 40 ft. It weighs 2,840 tonnes and is said to be the most advanced tunnel-boring machine China has developed.

SOURCE: *MailOnline*, 18 January 2019.

### **Reopening of Tyne foot tunnel delayed**

A historic crossing under the River Tyne is now likely to reopen four years later than first planned. The restoration of the Tyne pedestrian and adjacent cycle tunnel has been dogged by setbacks and renovations have now taken about two years longer than its construction.

Newcastle City Council said fitting glass enclosures on the new inclined lift had been a “challenging milestone”. A spokesman for the authority, which manages the tunnel on behalf of the North East Joint Transport Committee, said, otherwise the tunnels were “substantially complete”. Once this is completed and the lift is operating correctly, the official reopening date which is expected to be April will be announced. The work, which started in May 2013, was supposed to be finished by 2015.

But the original contractor going into administration and the discovery of asbestos meant the opening date was



pushed back several times. In 2018 it emerged the cost of the project had spiralled from an estimated £6.9m to an expected £15.65m. The crossing originally opened in 1951, taking four years to build at a cost of £833,000.

SOURCE: *BBC News*, 20 January 2019.

### **LATE NEWS**

#### **Friends of Williamson’s Tunnels nominated for tourist award**

A new ‘Hidden Gem’ category at this year’s Liverpool City Region Tourism Awards has produced an interesting and diverse shortlist.

In the first round the public were asked to nominate their favourite ‘must see’ gem across the city region, as long it was off the main tourism trail. It could be a tucked away bar or restaurant, attraction, tour or natural asset. The final short list of 10 sites included Friends of Williamson Tunnels – A labyrinth of tunnels and underground caverns in Edge Hill and preserved by a group of volunteers.

The public were given three weeks to vote for their favourite hidden gem. Voting closed on 25 April 2019 and the award will take place on 16 May at Liverpool Cathedral.

SOURCE: Liverpool City Region Local Enterprise Partnership website.



# Preparing for Armageddon: the Cold War bunker at Gravesend

## Part two: Operational history, decommissioning, heritage conservation and public access

**Victor Smith**

*Part one examined the origins, design and building of the bunker in 1954 as a civil defence control centre and described its intended method of working. This second and concluding part covers its operational history, expansion of its geographical area of responsibility, unrealised schemes for enlargement of the premises, decommissioning and re-use as a council store, followed by heritage conservation and public access. There is also a brief discussion of the successor control at Gravesend's Civic Centre and inclusion of other defensive context.*



*Bunker guides in the room designated to be occupied by liaison staff*

Volunteers from the Civil Defence Corps and others assigned to operate the bunker acquired the necessary skills to do so through a regime of training. There was separate training for the other parts of the Corps. From time to time there was participation in civil defence exercises, whether locally or further afield. On at least one occasion in the early 1960s the reason for the existence of civil defence and the function of the bunker were promoted to the local community by means of an open day. This, from the recollection of an activist involved, was used as an opportunity by the Campaign for Nuclear Disarmament (CND) to demonstrate inside. But for most of the time the bunker assumed an air of secrecy in public perception. This stimulated baseless local rumours, one

being that it was a place to which privileged members of Gravesend's council would go for sanctuary in the event of a threatened attack and another was that it was a vault for money and valuables.

The operational life of the bunker saw upgrading of its equipment as well as changes to the types and arrangement of furniture, particularly in the control rooms. The details of this are limited, relying upon slight references in contemporary official documents and the memories of members of the Corps and others who visited the premises during its operational life. A complaint from those training there was of a pervasive dampness which resulted in the impaired operation of some equipment, including the telephone switchboard.



The bunker would, of course, have been a vital focus for locally-based civil defence operations after an attack. Moreover, and depending on the levels of destruction or disruption, it might have come to be one of the few places in the locality at which there was a degree of remaining organisation and communications. In a situation of the possible breakdown of order in the community and the emergence of public hunger, the bunker could also have been at risk if it was thought to be a place where food supplies might be seized, requiring it to be defended. The police were to control public order failures and disturbances and part of the role of the Territorial Army was to assist civil authorities in the event of war. Either might have needed to be armed for the purpose.



*Imaginative enactment of a soldier defending the bunker against looters*

### **Civil Defence and the H-bomb**

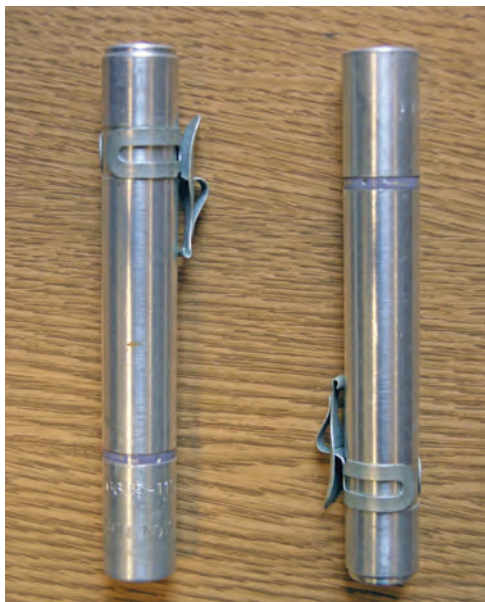
The Russians had been manufacturing air-deliverable atomic bombs for several years and the number of TU4 bombers to carry and drop them had increased. In addition, there was the entry into service in 1954 of the TU 16 jet 'Badger' and of the enduring TU95 turbo-prop 'Bear' in 1956.



*TU 95 'Bear' in flight*

As a result, the measurable danger appeared greater but as intelligence findings later revealed, quantitatively

this was not quite as much as the West had feared. The apprehended threat dramatically increased with the invention and development of the devastatingly more powerful and destructive hydrogen or thermo-nuclear weapon, tested by the United States in 1952 and then by the Soviet Union in 1953. As with the atomic bomb, however, it took time before the Soviets were able to add sufficient numbers of these to their armoury to present a quantum threat in volume, rationing of available supplies of weapons still being necessary. Although this constraint was understood by government, the apocalyptic nature of this weapon was, of course, very unsettling both for the population and for those responsible for devising schemes of military protection and civil defence, especially as although its full potential and ultimate scale of destruction could be imagined it had yet to be precisely determined. The certainty of frighteningly increasing bomb yields, leading to the prospect of ever more widespread levels of destruction and of irradiation from a thermo-nuclear attack became gradually, and then rapidly, transformative to strategic home-defence thinking. However, predicting the scale of an attack was not an exact science, and depended upon a range of assumptions concerning probable targets and the power of the warheads likely to be used. A report of 1953 to the Home Defence Committee postulated 1.4 million deaths and .75 million injuries arising from an attack of 132 atomic bombs. But a later report of 1955, with an eye to thermo-nuclear attack, envisaged the possibility of Britain being struck by 100 megatons, resulting in 12 million deaths and 4 million injuries. There was no certainty of an attack close to Gravesend. But when, with the adjacency of Tilbury Docks, Thameside acquired a power station at Tilbury in 1956 and in 1963 another at Northfleet, this area might have gained in importance for targeting to destroy this collective infrastructure. Had such an attack occurred, perhaps with a 100 kt. weapon, this would have shaken the bunker 1 ¼ miles (2 km) away, with diminishing destruction to about 6 miles (9.5 km) or more at the extremity of the blast. Depending upon the height of the burst and whether its fireball had contact with the surface, there might have also been radio-active fallout. Blast damage and, with the presence of an unfavourable wind, fallout, might have reached the area from bursts elsewhere, for example from attacks on the Chatham naval base and on London. It may be that the paralysing effects of the destruction of London would have been the primary objective. A strategically placed spread of 10 H-bombs across the country was considered by some British defence planners to be sufficient to so disrupt the life of the country as to make any semblance of normal activity impossible. It was thought that should, after an attack, 40-50% of the surviving population be absorbed by striving for their own survival to the exclusion of all else, a breakdown of the country as a functioning entity would be likely to occur.



*Dosimeters to measure radio-active fallout*

The introduction of the H-Bomb had led some to question the adequacy and indeed the viability of civil defence. Although in the minority, some civil defence commanders and volunteers are reported to have begun to see the earlier expectations of civil defence rescue as a fantasy. Little more than a month before the ceremonial opening of Gravesend's bunker in July 1954, a recognition of the power of the new bomb had brought about a need for an assuaging Parliamentary Statement by the Home Secretary for the benefit of the country acknowledging the problems that the new threat posed, but asserting the greater and more important part that civil defence and the Corps had as a result to play, adding that 'however great the area of damage, there would still be a large marginal zone in which the civil defence service would be useful and, indeed, desperately needed.' There was an imperative, it was argued, to press on vigorously with the recruitment of volunteers for the Civil Defence Corps, the Auxiliary Fire Service and the NHS Hospital Reserve and to work for greater liaison with the armed forces. As an early sign of an adjustment to changing times, it was postulated that in future there would probably be a greater emphasis on the precautionary dispersal of civil defence assets and services outside the main areas of population, and the assumed targets at risk, with increased use of mobile assistance columns leading, in 1955, to the formation of the Mobile Defence Corps. This was drawn from National Service men and civilian volunteers 'in support of the local civil defence services, wherever the need is greatest'.

### Civil defence exercises

In order to try to test whether under the new circumstances - and the certainty of greater devastation from a nuclear attack - civil defence operations would work on the day, there was a national cycle of the earlier-mentioned training exercises in which taught skills might be honed and preparations tested through practice. In Kent this included Mercury and Hermes (1954), Reform, Redress and Remould (1957), New Era (1958) and others. Command of civil defence services in the community was rehearsed, whether from control centres or from other impromptu venues such as a hall, with tables laid out in another room to simulate an array of warden posts. Paper exercises were held. Practical training in rescue and ambulance work was carried out by the appropriate sections. Exercises took place at various locations and, among the attendees, were participants and observers from Gravesend. Most of the range of civil defence responses and the involvement of the associated public and other voluntary agencies could, by various methods, be practised. These exercises often assumed that the Corps and other bodies would be at their wartime establishments and be fully available when needed at the time of a real attack, together with reserves which could be called in as mobile columns. The disruption produced from a large-scale nuclear attack might have meant otherwise. Concern about the Soviet threat among NATO home defence planners and partners worsened after the surprise Russian launching of the Sputnik satellite in 1957. This suggested to some that the west had fallen behind in long-range rocket technology, with the certainty of its adaptation to allow the delivery of nuclear warheads against NATO assets and territory.



*A room-based exercise attended by firefighting and civil defence personnel at Maidstone at an uncertain date. For the purposes of the exercise, the map has a nuclear explosion just to the east of Gravesend. Photo Kent Firefighting Museum*

There continued to be publicity events intended to recruit volunteers, whose strength across the Gravesend-Northfleet-Swanscombe Sub-Division had reached 242 by November 1957. As in much of Britain, there were regular audibility tests for the air-raid sirens (of which there were now 12 in Gravesend), ensuring that they continued to work. This also, however coincidentally, was a reminder to the community in which they were situated and to the country at large that a Cold War existed and the dangers it posed. Gaining approval for civil defence works, to ensure compliance with recommended provision, could be subject to the delaying effects of local and county council committees, the Home Office and other government departments, on occasion seeming to perform a bureaucratic dance. This was exemplified in discussions about garaging of civil defence vehicles on the King's Farm playing fields at Gravesend, envisaged as a base for key deployable assets in the Sub-Division. About this time central government began to issue guidance to the public about how to protect themselves in the event of an attack. This included suggested designs for making refuges at home.



*The playing fields at King's Farm, intended as a base for vehicle-deployable assets.  
A Second World War Decontamination Centre is in the foreground. There are reputed to be buried structures under the playing fields*

### War plans for public services

As well as the locally-based organisation of civil defence control centres and other Corps infrastructure across the country there were war plans for Post Office telephone services, the Police, gas, electricity and water suppliers. Each appears to have had limited protected accommodation on Thameside, from which to attempt to continue services after an attack. Elsewhere there was protected accommodation for BBC emergency broadcasting.



*Redrawn by Victor Smith from an original civil defence document.*

### Reorganisation of civil defence in Kent, 1958

A government decision in 1958 to rationalise the operational structure for civil defence across the country began a period of what amounted to continuing national organisational review and change. In Kent, this was to require the reduction of its existing 14 Sub-Divisions into 7 Areas. The old Sub-Divisions had, of necessity, to become larger, so the responsibility of Gravesend's bunker was scheduled to expand to include neighbouring Dartford. This became designated as Area 'A', consisting of Gravesend and Dartford Municipal Boroughs (MBs), Dartford Rural District (RD) and Northfleet and Swanscombe Urban Districts (UDs), more than doubling the size of the catchment area. Within this was to be a Sub-Area for Gravesend, the equivalent of the old District.

This reorganisation took time to coalesce and it was not until July 1959 that the Town Clerk of Gravesend was nominated as the Area Controller. His station in the event of a nuclear conflict was to be underground in the bunker. The war duty establishment for the Gravesend sub-area was now reckoned to be Headquarters Section 55 (including control centre personnel), Warden Section 92 and Rescue Section 121. There were to be 8 warden posts, each reporting to one of 2 sector posts in the Sub-Area. As in other parts of the country some existing warden posts in Gravesend were still being used by youth organisations. It can only be assumed that these were regarded at the time as being in the wrong places for civil defence purposes. Without a known reasoning it was decided that for the future there would be one warden post for each electoral ward in Gravesend although how these were to be provided and in which premises is unclear. A reactivated Second World War post in Northfleet became a training centre for local wardens.

Further details of the air-raid warden organisation have not yet come to light. At other dates some of the posts might have been designated as parent posts. Government proposals of 1957 envisaged that future provision of



sector posts, which were intermediate between warden posts and control centres, would be by means of mobile vehicular units. The intended local communications chain for reporting and deploying civil defence forces to carry out their tasks in the community could, of course, have been disrupted as the result of an attack. There were contingency plans for adapting to that.

Connected with the Area Control Room at Gravesend, Northfleet continued to have its own control centre but the nature of local control for operations in the Swanscombe part of the new Area is unclear from the records. As mentioned earlier, Swanscombe's wartime control centre had been at Knockhall Lodge and this had money spent on it in 1952, implying its renewal, on however limited a scale. It subsequently no longer featured in civil defence papers, with only a mention that control arrangements for Swanscombe had yet to be determined against the background of wider government reconsideration of controls in the light of the appearance of the hydrogen bomb. Central advice predicted more use of vehicles as mobile controls. Indeed, in 1958, one of the latter became allocated generally to Area A (presumably being available or actually earmarked for Swanscombe), along with a reconnaissance vehicle.



*Training Centre at 60 Pelham Road, Gravesend*



*Training Centre at Vale Road, Northfleet. Civil defence ambulance garages are on the right*

For command and control generally telephone communications were always capable of improvement and those at Gravesend's bunker were supplemented with more outside lines. There was also a new national initiative to secure more premises for training. Locally, between 1958-61, these were provided through the purchase of 60 Pelham Road, Gravesend (for the Gravesend Sub-Area), and the building of new halls at Vale Road, Northfleet (for the Northfleet Sub-Area) and at Church Road, Swanscombe (for Swanscombe Sub-Area), with other facilities provided at Dartford.



*Training Centre at Church Road, Swanscombe*

Recruitment of volunteers continued to be a struggle and despite the known dedication and achievement of the predecessors of the Corps during the Second World War, interest in membership is remembered by some former volunteers as having suffered to a degree from the mockery of elements of the population. There was also protest against the Corps by activists inspired by the CND. Meanwhile, with the decision to end National Service which had provided many of the personnel for the Mobile Defence Corps, this organisation was discontinued. It was succeeded in a lesser way by the use of the Territorial Army.

### **Loss of active air defence for Thameside in the 1950s and 60s**

In terms of local military preparation, the Thames had ceased to have estuarial coastal artillery batteries since the disbandment of coastal artillery in 1956. Anti-aircraft batteries which had embraced the Thames against the attack of bombers were similarly lost as that branch of the army was also discontinued, it being concluded that guns on the ground were no longer an effective defence. The number of fighter interceptors which had been based a short flying distance from the Thames was also slashed. Although manned bombers, which presented in hundreds, continued to be a threat, by 1960 Britain could be reached by Russian ballistic missiles such as the SS4 and SS5 and, not long after this, from missiles launched from submarines. An attack on Britain of up to 477 megatons, causing 21.5 million dead was now considered to be a possibility. Any conventional bombing was likely to be limited in scope, being only against specific targets





*A 6-inch breech-loader at Garrison Point Fort at Sheerness, supplied from underground magazines. Pictured shortly before the disbandment of British coastal artillery in 1956. Victor Smith archive*

at the outset of war, soon to be succeeded by a nuclear attack. British nuclear counter-strike capability was then mainly based on the jet V-bomber force which had been developed in the 1950s. This was reinforced by the deployment of United States-built Thor intermediate-range missiles sited on British territory, under joint US and British command.

### **Regional Government**

By now Britain's Regional War Room organisation, which would have directed life-saving operations after an attack, was being replaced by a new network of larger and more capable protected Regional Seats of Government (RSGs). As part of this by 1958 the building which had been used as a War Room at Tunbridge Wells was decommissioned. The main role of RSGs was to carry out a prepared strategic plan for the restoration and recovery of the area for which they were responsible, at the same time re-establishing, and if necessary enforcing, government control. Under a Commissioner, some of whom were likely to be of ministerial rank, they were to have staffs of several hundred drawn from government

departments, health, utility services, the armed services and others. Kent came under an RSG formed in 1962 in tunnels below Dover Castle from which there would also have been communications links to the county authority. This was a courageous choice, given that Dover was an important cross-channel port, of probable use for the resupply of British and other elements of NATO forces in Continental Europe and, in consequence, a likely target for attack. The ability of Britain to provide reinforcement and supply to the Continent might not long have survived the first nuclear bombardment.

It has been suggested elsewhere that by 1963, the War Room at Tunbridge Wells had been redesignated for sub-regional functions.



*The Regional War Room at Tunbridge Wells. Photo Nick Catford*

Kent was now designated as Civil Defence Group 121, with the Group Control in a basement at County Hall, Maidstone. The Sub-Area commanded from Gravesend was numbered 121A.

Reaction to the greater power of the Hydrogen bomb was expressed in continuing emphasis on an intention to disperse civil defence assets outside the expected areas of maximum devastation, with rendezvous points from which columns of whatever assistance forces remained after an attack might move to attempt rescue and recovery, mainly on the fringes of destruction. Evacuation of vulnerable groups of the population was still being considered by Home Office civil defence planners, destinations envisaged being in Western England, Wales, and even still to parts of the SE of England. Announced in 1963, the Beeching railway cuts were to have a reducing effect on the national transport infrastructure and so upon evacuation plans.

During the Cuban Missile Crisis of 1962, the very time when Britain and her NATO allies were most at risk from nuclear attack, the British V-bomber force and American Thor missiles were placed on stand-by. Although civil defence commanders were well aware of the dangerous situation and the risk of the outbreak of war, the Corps itself was not mobilised. This was a political decision. It has been suggested that this was for fear of sending a provocative message of war preparation to the Soviets.



*The Tape Relay Centre with the Signals Centre in the RSG at Dover Castle. Photo Nick Catford*

**An unrealised proposal, 1961**

About this time there was a proposal to transfer the Sub-Area control for Gravesend to a new civic centre to be built at Woodville Terrace and, in consequence, for the bunker at Woodlands Park to be used solely as the parent Area Control. In 1961-2, approval for works was given by the Corps authority for extension of the bunker to provide greater operating space. Also envisaged was the



*Civil Defence Headquarters armband*

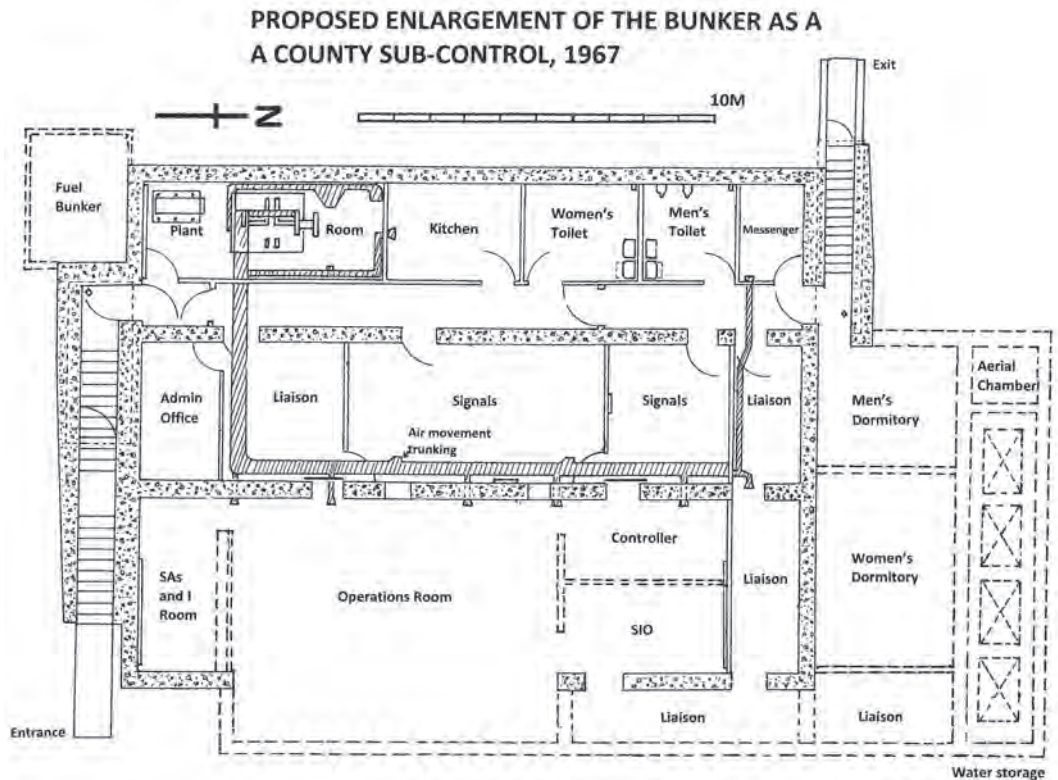
making of a covered way to the adjacent Woodlands Hotel wherein could be found accommodation said to have been suitable for the rest periods of the bunker personnel. So too, a 65 ft. (20 m) high wireless aerial, for which planning permission had been obtained, was proposed to ensure satisfactory communication with the Group Control at Maidstone. A design flaw of the bunker leading to rain water penetration of the concrete roof was corrected by the addition of a sealing layer of asphalt. Decisions about the reorganisation of the bunker were overturned when, in February 1963, Kent County Council affirmed that there was no prospect of making space for a Sub-Area

Control at the Civic Centre. The existing bunker at Woodlands Park had, therefore, to continue to be used for both Area and Sub-Area functions. In this year also began a prolonged and ultimately fruitless discussion about the acquisition of the former anti-aircraft gun site at Northumberland Bottom on the outskirts of Gravesend for use as a combined civil defence training ground for various units, although some training at this site had actually already taken place.

**County Sub-Controls, 1963-66**

The journey of organisational change in civil defence continued through 1963 into 1964. First there was a decision to divide the county into 29 Civil Defence Districts (a number later reduced): Dartford and Gravesend/Northfleet/Swanscombe were to become separate districts. Second, it was resolved to introduce a layer of sub-control below the main county control centre at Maidstone in the form of controls at Ashford, Tunbridge Wells, Canterbury and Gravesend. The sub-controls were not just to coordinate life-saving operations but because of their protected nature and the presence within them of crucial communications equipment they were also, if need be, to be used post-attack as available subordinate points to assist administration during ‘the survival period’. This was something of a departure from the assumptions initially arising from the Act of 1948, and expressed the likelihood that the exceptional scale of destruction from an attack would dislocate some of the essential organisational sinews of local and wider government. At the same time there was revised and updated administrative provision for local authorities to plan rest centres and to billet people made homeless by the effects of enemy action. Based on Second World War arrangements, there was already a national scheme for buffer food stores where emergency supplies of food were to be kept.

In the new scheme, some £8,000 (an amount later reduced) was estimated as the cost of expanding and converting the bunker at Woodlands Park for use as a sub-control. Indeed, between 1965-6 the plans for this were drawn, possibly in part adapted from the proposals



*Plan of 1967 showing the proposed enlargement of the bunker. Redrawn from an original civil defence document by Victor Smith*

of 1961/2. These envisaged (a) construction of a fuel store by extending the bunker into the ground at the bottom of the entrance staircase, (b) the extension of the east wall of the bunker to provide more operational space (c) an extension of the north wall to relocate sleeping accommodation, as well as to provide extensive water storage and (d) works to create a chamber for a new aerial array. The overall intended result was to increase the internal space and to reorganise its functional elements. The last-known proposal plan was one of 1967 (on previous page) in which there was to be a substantial allocation of space for liaison staff.

The Sub-Controls were also been designated as shadow controls in case the county control at Maidstone was put out of action, in which case one of them would take over as a control for the whole of Kent. Despite the best of intentions, work at Gravesend again remained unstarted. But it is possible that the existing aerial mast dates from this period, albeit of a lesser height than that proposed in 1961/2.



*The radio mast*



*Close-up of the microphone symbol on an access plate near the bottom of the mast*

Matters were no better elsewhere, with accommodation still to be agreed for the Sub-Control at Tunbridge Wells. An offer of a site at Canterbury was received without a definite way ahead and there was great uncertainty at Ashford where there was only a possibility of inclusion of a control in a new civic centre, whose construction was thought to be 3-4 years in the future. Enlargement of the bunker at Gravesend was never carried out.

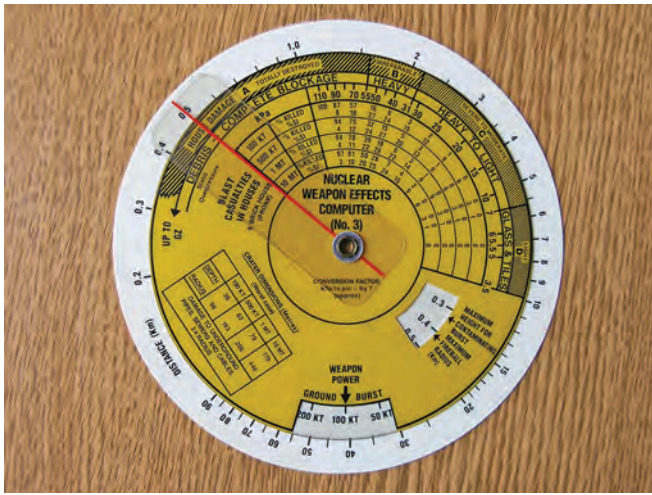
### **'The War Game'**

Gravesend had a part to play in Peter Watkins' seminal drama-documentary, 'The War Game' of 1965, portraying the lead-up to a war between the Soviet Union and NATO and the effects on Kent of a nuclear attack on Britain. It suggested that civil defence could not have coped with the aftermath. Among a number of incidents included in the film was the looting of a food storage compound in Gravesend. Members of a local drama group and others were included as actors and extras. Banned from being broadcast at the time, this film was nevertheless screened at some cinemas and other venues, not to be shown on television until years later. The writer remembers its subduing effect on a military audience after being screened at the School of Infantry in 1970. The passage of time has not diminished its emotional power.

### **The end of the Civil Defence Corps and inception of a period of care and maintenance**

Presaged by a statement of the Home Secretary in December 1966, the emergence of a serious national balance of payments crisis challenged the established regime of civil defence. There had already been a growing recognition that without vastly greater provision at an unacceptably higher cost, the probable scale of destruction in the event of a nuclear attack would have overwhelmed the civil defence arrangements then in being, even with pragmatic reduced expectations of them. It was decided to shrink the size of the Civil Defence Corps and to eliminate the separate sections for rescue, ambulance, first aid and welfare, concentrating upon helping to provide an efficient communication and control system, although rescue work was still to be taught. Britain's local authorities were advised to make the fullest use of their own staff for civil defence purposes. As an example of this, in Gravesend an attempt was made in February 1967 to reduce numbers of Corps personnel by urging that volunteers from council staffs be used, resulting in council and library staff being given training at the bunker in communications and control. The process was reinforced in October 1967 by a request to Gravesend's council as well as to all others, to use their own staff to man control centres and warden posts, using Civil Defence Corps staff only where this was not possible.

These changes had, in fact, produced the genesis of a national scheme that attempted to recognise and adapt to the new circumstances. This was a solution that provided



*A bomb effects calculator*

a nucleus for communications and coordination for the activation of existing public services such as fire, police, emergency NHS staff, local authority works personnel and others while, at the same time, retaining the expertise of the Corps. It remained for this intended partnership to be melded. However, before this could happen, central government decided to proceed without involvement of the Corps which was stood down in 1968 as part of a scheme to place this aspect of home defence into a state of ‘care and maintenance’. Civil defence training premises were closed, with vehicles and equipment withdrawn and disposed of.

Not only was the Civil Defence Corps discontinued but also that element of the Territorial Army which, following the demise of the Mobile Defence Corps, had been designated as having a post-attack assistance role, along with the Auxiliary Fire Service and the NHS Hospital Reserve. Moreover, the Royal Observer Corps, a civilian voluntary body which had evolved from aircraft spotting to post-attack radiation monitoring from underground posts, had the number of its sites halved. There now ceased to be a force of personnel to handle civil defence in the earlier-understood way. Post-attack rescue was to be considered only where practicable and in lesser-affected areas. About this time also there was a change of thinking about evacuation: given that nowhere would be safe from radioactive fallout, this was seen as pointless and unworkable. Instead a ‘stay-put’ policy was decided upon for the population at large. As a result Thameside ceased to be an evacuation area. In practice much of the population was, therefore, to be left to its fate, survivors in the most severe and terminal categories being likely to be denied assistance and contained, if necessary by force, to prevent them entering less devastated areas to claim resources that would be better given to those likely to survive and to be able to contribute to national recovery. It was, therefore, tacitly and pragmatically accepted that in the event of a nuclear war – especially an all-out one – lesser attention would be given to heavily devastated areas and that all that could be done was to try to rebuild the nation from what was left of its population and

resources outside them. Bunkered government across the regions continued to be the focal points for recovery but it had been realised that conditions after a nuclear strike might be even more fractured than first thought and a decision was taken to establish 25 Sub-Regional Headquarters (SRHQs) to assist during the recovery phase. This national programme was started but never completed.



*Control Room in the county control at Maidstone in 1988*

The recently-constructed county control at Springfield, Maidstone (1964) could, in theory, and if still operative, have become a communications node for civil recovery in Kent while the bunker at Woodlands Park remained designated as a Sub-Control despite the earlier-planned new works not having been undertaken. Its equipment was retained, heating and ventilation kept running at regular intervals on a time switch and the premises cleaned once a week, to keep them ready, if needed for reactivation. The control centre at Northfleet was also retained under care and maintenance.



*The former council offices at Northfleet. In the basement of this and under the car park to the rear was Northfleet's control centre*

A government assessment of 1970 predicted that 106 cities, towns and military bases across the country were probable nuclear targets, including London, the Medway Towns (within which the Chatham naval base was situated), RAF Manston and Dover but, as observed

elsewhere, there was an omission of power stations and other key infrastructure, which are thought to have been within the scope of the Russian attack doctrine.

### **From the early 1970s**

Some officers at the Home Office attempted to act as a pressure group to promote, though unsuccessfully, a continuing need for a civil defence organisation, including in a rescue sense. In Kent there was modest and ultimately failing move to form a financially unsupported voluntary organisation as a successor to the Corps. To add to a sense of confusion, neither the government nor local authorities opposed such initiatives and one or two outside Kent lasted until the end of the Cold War. Although there was no longer a Civil Defence Corps, as for other county authorities, Kent County Council remained statutorily responsible for all emergency functions in the county under the Civil Defence Acts. This included maintenance of its county control centre. After 1974/5 the stand-by function for Gravesend's bunker ceased, with moveable equipment being extracted, but fixed furniture was left. Thereafter, the bunker became used as a store for local historical muniments and for items forming part of a collection of Gravesend Library. With the introduction of shelving, the bunker was also a repository for some 20,000 closed files belonging to Gravesham Borough Council.

Coordination of emergency arrangements in Gravesend now came to depend upon room spaces made available at the recently-constructed Civic Centre in the middle of Gravesend. Details are unclear but, as part of the arrangements, extra telephone jacks were provided in committee rooms.

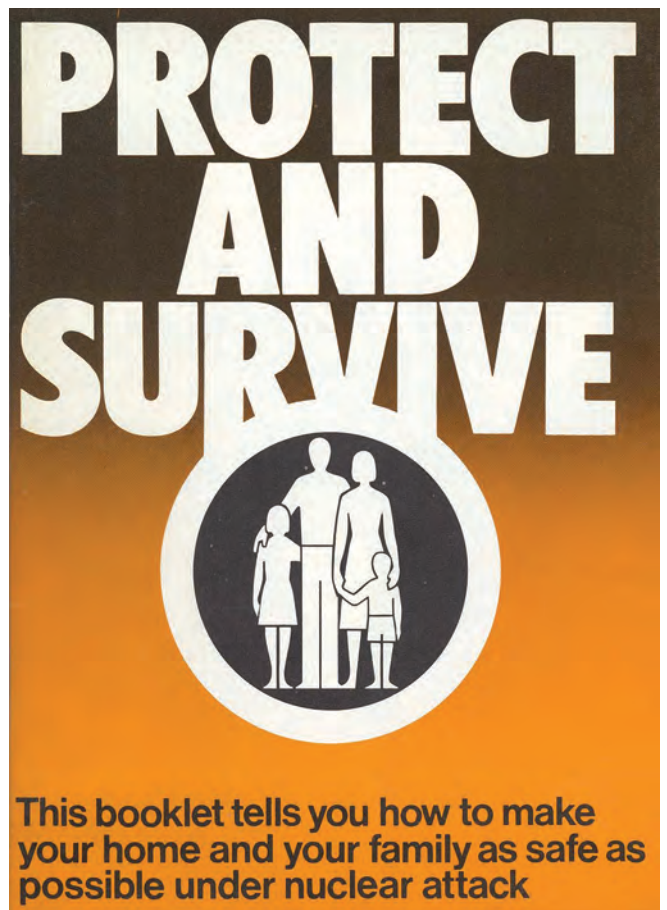
### **Increased international tensions and a revival of preparedness in the later 1970s and 80s.**

Following the intent of the earlier government reorganisation of civil defence, most activity had, however modestly, focused upon improving the communications network and holding related exercises. This period had in some degree been one of an easing of relations between NATO and the Warsaw Pact, generally labelled as 'détente'. But by the later 1970s serious tensions re-emerged, punctuated by (a) what was seen as the provocative siting of new Soviet SS20 intermediate range missiles in Eastern Europe and (b) the decision of the West to station Pershing II and cruise missiles on European territories. In 1983 the NATO exercise 'Able Archer' was feared by the Soviets to be a prelude to an attack upon them. Already, by 1980 and a new Home Defence Review, a worsening situation had led to a decision to increase the annual national spending on Britain's civil defence. Among a range of actions, and in support of county controls, it was decided to rejuvenate the local authority/civil defence communication and emergency service coordination network, often in controls in new protected accommodation, as well as to form organisations of community volunteers. In Gravesend these initiatives began during 1984/5.



*A new control centre at Woodville Halls, Gravesend, was under the block to the right*

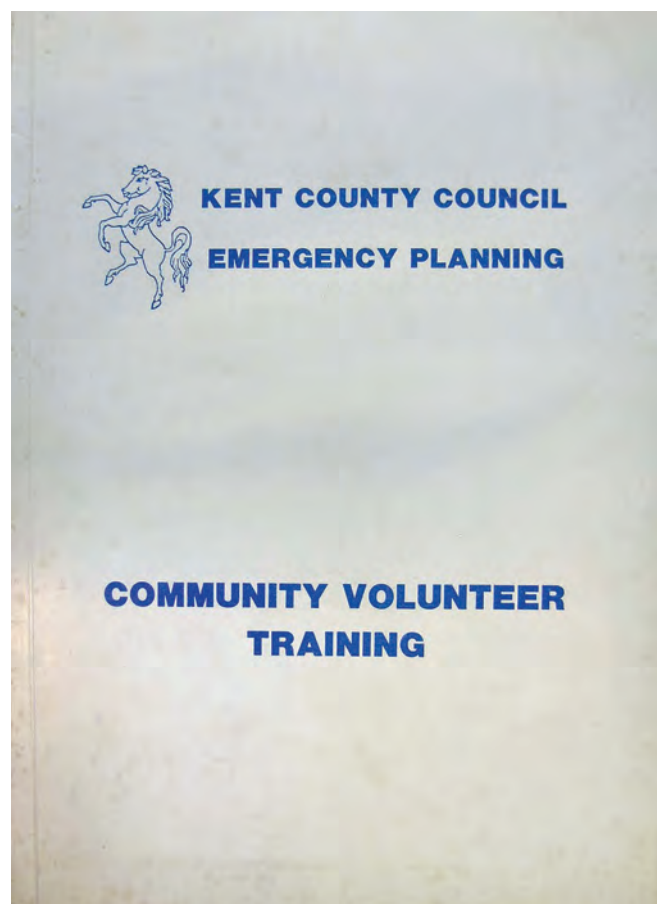
Meanwhile the scale of the nuclear threat had increased exponentially, both in terms of the numbers of warheads and improvements in the systems to get them to their targets. The situation of Mutually Assured Destruction (MAD) in the event of a nuclear war had long been reached. Alongside a perceived threat of nuclear apocalypse there was also a theoretical risk at least of the use of chemical agents for area-denial on the fringes of nuclear destruction and perhaps the employment of biological weapons against people or crops. Among the various home defence exercises at different dates was 'Square Leg' in 1980, which postulated a Russian nuclear burst in the waters of the Thames estuary, producing a tidal wave and a large and harmful radioactive cloud.



In 1980 the government produced revised public guidance in its now famous booklet (some consider infamous) *Protect and Survive*, explaining ‘how to make your home and your family as safe as possible under nuclear attack’. This was followed in 1981 by a Home Office publication *Domestic Nuclear Shelters: Advice on Domestic Shelters Providing Protection against Nuclear Explosions* about how people could provide shelters for themselves and at their own expense.

### **The Kent Community Volunteers**

In Kent the new volunteer organisation was called the Kent Community Volunteers. These were mainly based in rural parishes where it was thought possible that there would be a remaining focus from which something might be rebuilt after an attack. As a wider-reflective case example, in Gravesham volunteers began to be formed in the villages of Meopham and Cobham, with other groups being started at Hook Green, Culverstone, Vigo, Harvel, Sole Street and Luddesdown. Recruitment in the urban wards was also envisaged. Without significant financial backing and infrastructure, it consisted of a regime for training volunteers in first aid, fire-fighting, radiation detection, field cooking for large numbers of people and setting up tented camps. Tents, cooking equipment and other resources were stockpiled elsewhere in preparation. Several public houses were designated as local communication centres. However, within several years this initiative fizzled out and no known archaeology remains.



*The cover of the handbook for the Kent Community Volunteers*

### **The new control centre at Gravesend's Woodville Halls**

From a communications and emergency services coordination point of view, planning for both war emergencies and civil contingencies was combined in an ‘all risks’ approach. The new centres for this were generally to be co-located with or within council offices where relevant services such as the Borough Engineer and the Housing Department were likely to be already based. Not entirely innovative, this followed practice adopted by some councils during the later 1930s, the Second World War and after. This was now the case in Gravesend: although reoccupation of the bunker at Woodlands Park had been considered, it was rejected in favour of using specially adapted space in the basement of Woodville Halls which adjoined the Civic Centre. The originally-selected rooms in the council complex were judged unsuitable. The approved space was thought to be sufficient against fallout. Mounted with wall-maps, at its core was a communications room which was provided with a switchboard, telephones, radios (to be partly operated by the RAYNET group of radio amateurs) and teleprinters, with connections for the police and fire networks. Subsequently introduced was a safe-like cabinet containing a terminal for the Government Communications Network (GCN). Aerials were erected on the tower roof of the Civic Centre. In the event of the failure of the National Grid, there was to be a 12.5 kw or 15 kw standby generator. There was a kitchen and mattresses as part of impromptu sleeping arrangements.



*The former communications room in the control centre under Woodville Halls in 1991*

Two of the country's and the county's designated essential road routes for official and military traffic in a war passed through Gravesham: the east-west A2 and, connecting to Gravesend and its ferry crossing, the A227. Co-location of new control centres with council offices was followed elsewhere in Kent, for example at Dartford, Strood, Ashford and Dover. Canterbury was to have protected premises for a joint District and County standby but this proposal was overtaken by the end of the Cold War.



*Ground sockets in front of the windows of part of the council offices at Dartford. These were explained by a former official as having been for the insertion of timbers to be faced by thick planking, against which a bank of sand was to be piled to give protection to the ground-level control centre behind*



*The emergency exit from the Dartford control centre into a council car park in 1995*

Regional government organisation had by now again mutated, with the decision to divide England into 9 regions, each with a Regional Government Headquarters (RGHQ), often a former RSG. The Dover Castle RSG had been abandoned in 1984 and successor premises were designated at Crowborough in Sussex.

### **Current and future threats**

The basement premises at Woodville Halls in Gravesend remained in use as an emergency centre for several years after the official end of the Cold War in 1990, following which they became cleared and used for other purposes. This was part of a general reduction of such facilities across the country. In a return to earlier arrangements, responses to incidents whether civil or war related would, if necessary, continue to be managed from rooms at Gravesend's Civic Centre.

Civil defence in a recognisable historical sense hardly now exists. Gravesend and Thameside are embraced within the generality of national preparedness against international terrorism and these include some physical elements. Risks include the possibility of hostile chemical emissions from a ship in the river, a contingency to be handled variously via the control room of the Port of London Authority, the resilience teams of Kent County Council and Gravesham Borough Council as well as by other bodies. The nature of the threat continues to evolve, embracing the potential for cyber-attack on Britain, especially of its infrastructure, by states or hostile groups. A range of current and possible future regional and global tensions, including signs of a revived Cold War with Russia, as well as continuing international terrorism may yet produce external and domestic threats to the United Kingdom which could, on whatever scale of probability, include nuclear, radiological, chemical and biological attack. The Cabinet Office, the government department now generally responsible for civil preparedness, does recognise the risk of a situation emerging in which a nuclear attack on Britain and her allies might occur. Their envisaged warning time for the emergence of such a risk is generous but a current or future enemy may not choose to work from the same script. The disruptive effect of an electro-magnetic pulse, whether as part of a nuclear attack or produced by other means is another acknowledged risk for which it has been accepted that civil contingency plans are not sufficient.

### **Discussion**

As a constructional form, the civil defence control centre at Woodlands Park had origins reaching back long before the air attack era to the concrete casemates of forts in the later 19<sup>th</sup> century, intended not only to resist the falling projectiles of heavy artillery directly upon them but also the shock and vibration from explosions nearby. These were helpful design qualities of resistance to be adopted later, with metal reinforcement for added strength, through the age of air bombing and into the Cold War, for a variety of structures, including civil defence control



centres. The modular layout of the bunker at Gravesend and the way it was to function operationally as a control centre looked back as much to a 1930s and a Second World War frame of reference as it expressed the atomic age and its more destructive potentialities.

The bunker originated during a distinct historical phase as one of many Civil Defence Control Centres built or re-established across the country in the early 1950s. Often they were in the basements of council or other public sector offices, either as a continuation or as an upgrading of pre-existing facilities. Others were new-built under or on the car parks or grounds of such premises. That at Northfleet, which had formed part of the Sub-Division was, as has been mentioned, partly under a council car park and partly in a basement of council offices. Those built away from council headquarters were in a minority. Gravesend's bunker is therefore of special interest but is paralleled by others built at various dates on the outskirts of the ports and industrial centres of Bristol, Barrow, Rotherham and Edinburgh/Leith, as well as elsewhere. In some places across the country civil defence control centres were at locations which paid little regard to their liability to probable destruction during an atomic or nuclear attack because of the presence of adjacent targets. Civil Defence Control Centres had common components rather than standard designs, their requirements as set out in Home Office memoranda being the need for rooms for communications, command and control, liaison and emergency power plant, with the support of toilets, a kitchen and, sometimes, sleeping accommodation. There was to be a filtration plant for the prevention of the entry of war gases which also went some way to handle radioactive fallout and there were to be airlocks, although provision of the latter could be delayed or omitted. New-built structures, surface or buried were, of course, specially designed, usually with a spine corridor, having the relevant rooms off it. Being subject to the constraints of any existing rooms and buildings above, control centres in the basements of council offices were often of more adaptive layouts. The dual function of Gravesend's bunker was intended as a template for the whole of Kent. However, this aspiration was only partly realised elsewhere (as at Gillingham), the scheme becoming a victim of protracted reconsideration of the operational control organisation. Not having been later upgraded, the bunker at Woodlands Park has an additional and national heritage value arising from it being a rare example in good condition of an almost untouched control centre from the early Cold War, which retains some fixed furnishings from that time, a working filtration plant and some elements of its original decorations.

The interest of the bunker is enhanced by our knowledge of its part in the evolving operational organisation of civil defence, followed after a time by the re-establishment of a short-lived communications centre under Woodville Halls. The rise and fall of control centres in Britain was

reflective of the existence of a planned organisation for civil defence which, in a serious community rescue sense, existed for little more than half of the Cold War. Civil defence in Russia was emphatically part of its war-fighting organisation and was resourced and structured to that end. The approach adopted by the Warsaw Pact partners was subject to her influence and included the use of both regular and volunteer forces, but it was far from standardised. Like the Warsaw Pact, NATO partners' civil defence organisations could combine paid units with volunteers but did not follow an identical template.

### **Conservation and public display**

The existence and historical significance of the bunker was revealed by a study of the post-medieval military and civil defences of northwest Kent undertaken in 1990 for the Heritage Conservation Group of Kent County Council. This was followed in 1995 by a successful request of the New Tavern Fort Project (renamed Thames Defence Heritage in 2000) to Gravesham Borough Council for permission to undertake restoration of the bunker, remaining in their ownership, and to open it to the public. The latter was made possible by an underpinning programme of documentary research paralleled by the acquisition from a variety of governmental, local authority and other sources of the range of necessary furniture, equipment and fitments to produce an authentic refurbished layout. A consequence arising from this was



*A former ROC observer in the mock-up of an underground radiation monitoring post*

the removal of the large residue of council files which were an impediment to heritage development. Those of historical retention value were placed in an archival repository elsewhere and the rest, at the direction of the council, disposed of as paper scrap. Work had initially

started to create a visitor experience which combined presentation as a Cold War heritage centre with historical refurbishing of the remaining spaces as parts of the control centre.

Although a mock-up of an ROC underground post was created as part of an intended Cold War heritage centre (and has been retained), it soon became apparent that the rarity value of the bunker demanded display almost wholly as a Civil Defence Control Centre, in which its appearance and atmosphere could be recreated, all embraced within an interpretive explanation of the Cold War. With the generous financial support of the council, this was undertaken in phases. Even before completion, the first visitors were received in 2000.



*The briefing room for visitors to the bunker*

The bunker was ceremonially opened as a museum in 2004, to mark the 50<sup>th</sup> year since its construction. This event was attended by Christopher Pond MP, senior council officials and local invited guests, as well as by George Rattray, the builder of the bunker and, remarkably given the history of hostility between the West and Russia, by Pavel Andreyev, an Attaché at the Russian Embassy who, together, unveiled a commemorative plaque.



*Pavel Andreyev, Attaché at the Russian Embassy, at the official opening of the bunker as a museum in 2004.*

*Photo Chris Pearce*

In an expression of continuity to the present, Kent Emergency Planning provided a wall panel bringing

the history of the county's civil defence up to date. Subsequently, and with the assistance of Adam Holloway MP, the casing of a British air-dropped nuclear weapon was obtained from the Royal Air Force for display inside the bunker, adding a powerful Cold War symbolism to the presentation.



*A British nuclear bomb displayed at the bunker*



*A guide standing next to a large bomb effects calculator used during visits by the public to the bunker*

As refurbishing of the bunker to its 1950s/early 60s appearance produced an ambience much in common with the 1940s, this attracted its use as the setting for part of a Second World War film *Age of Heroes* (2011). Following an application by the writer, in 2013 the bunker became designated as a Grade II Listed building.

Subsequent episodes of flooding led to the closure of the bunker to visitors in 2014, most of its contents being removed into storage to allow remedial works to be undertaken. These, organised by Gravesham Borough Council, were completed in 2017 and the bunker reopened in 2018.





Gravesend was chosen by the Royal Engineers in 2006 for carrying out a chemical warfare exercise, seen here at New Tavern Fort

are mentioned below:

All photos by the author unless stated.  
Minutes of the Civil Defence Committee for Kent from 1952-1969.  
Minutes of the Civil Defence Committee for Gravesend from 1950-1968 and those of the Watch Committee from 1948-9.

Numerous civil defence correspondence and memoranda in the C/Ad2 series at the Kent History and Library Centre, including those on War Planning across the county and in Gravesend, communications, exercises and training.

Documents in the HO205 series at the National Archives in Kew.

File entitled Civil Defence Control Centre, 1952-78, LAH17.

*Emergency Planning Guidance to Local Authorities: Emergency Feeding*, Ministry of Agriculture,

Fisheries and Food (1986)

*Emergency Planning Guidance to Local Authorities: Communications*, Home Office (1989)

*Kent County Council Emergency Planning: Community Volunteer Training* (1986)

*Kent County Council Emergency Planning for Kent* (1994)

*Civil Defence Instructors' Notes: Warden Section*, Home Office (1957)

Leaflet, *Domestic Nuclear Shelters*, Home Office (1981)

Leaflet, *Protect and Survive*, HMSO (1980)

*Manual of Basic Training, Vol. II, Atomic Warfare*, HMSO (1950)

Periodical, *Civil Defence: the Fourth Arm*, numerous issues during the 1960s.

Duncan Campbell, *War Plan UK*, London (1983)

N. Catford, *Subterranean Britain: Cold War Bunkers*, Folly Books (2010)

Anthony Cave Brown (Ed), *Operation World War III: (a reproduction of the American Dropshot plan of 1957 for war with the Soviet Union)*, London (1978)

Robin Clarke, Rapporteur, *London Under Attack* (a report of the Greater London Area War Risk Study), Oxford (1986)

Wayne D. Cocroft and Roger J.C. Thomas, *Cold War Building for Nuclear Confrontation, 1946-1989*, English Heritage (2003)

Jeremy Isaacs and Taylor Downing, *Cold War*, London (1998)

N.J. McCamley, *Cold War Secret Bunkers*, Barnsley, (2002)

Royal United Services Institute, *Nuclear Attack: Civil Defence: Aspects of Defence in the Nuclear Age*, Oxford (1982)

Peter Ware, *Cold War 1946-1991: Operations Manual*, Yeovil (2016)

### Acknowledgements

The writer thanks the Kent History and Library Centre and the National Archives for access to an extensive range of documents consulted for this study which has been produced for the Historic Defences Committee of the Kent Archaeological Society. Historical information and suggestions used in this article were gratefully received from Mike Clinch, Wayne Cocroft, Commander Ian Dunkley, Tim Essex-Lopresti, Steve Fox, Keith Gulvin, Tony Hill, Jenny Neesam, Martin Dixon, Nick Rowe, Roger Thomas, Shirley Whatmough, George Willcock and Robin Woolen, several of whom commented on a draft of this study. In earlier years former civil defence volunteers who served in the Gravesend Sub-Division shared with the writer their recollections of the bunker during its years of operation.

The writer also acknowledges those who helped him with their time, energy and expertise during his term as Director of the New Tavern Fort Project and of Thames Defence Heritage, when the restoration, refurbishing and first public opening of the bunker took place. Gravesend Borough Council is especially thanked for their vision in steadfastly supporting this important project.

Finally, the writer is grateful to Subterranea Britannica for their generosity in making space available in *Subterranea* for inclusion of this two-part article as well as to the editor Nick Catford, not only for his assistance with this but, earlier, for his information helpful for the display of the replica ROC post.

### Sources

Some 2,500 pages of original documentation and memoranda as well as numerous secondary sources were consulted for the writing of this article. The main ones



# Liverpool Visit – July 2018

Phil Catling



*SubBritters looking at the 1930s control equipment for the Mersey Tunnel, high in the George's Dock building.*

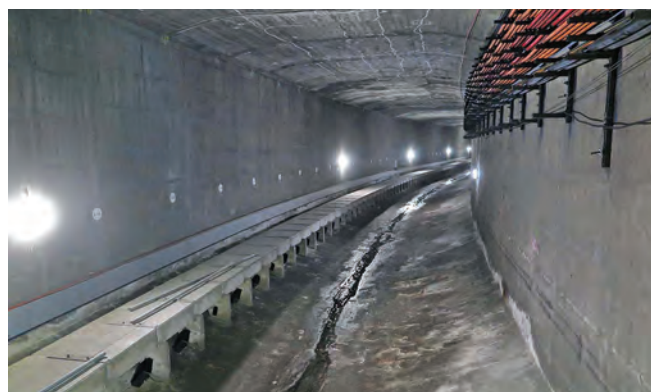
*Photo Phil Catling*

On Saturday 14 July, fifteen SubBritters came from all over the country and headed for the Irish Sea coastline. We braved the summer sunshine, mainline train stations that were closed (more on this later), and crowds of people there to see the launch of the RRS *Sir David Attenborough* – or *BoatyMcBoatface* as the Antarctic research ship will inevitably become unofficially known. The locations we were to visit, dug from the Liverpool sandstone, would surprise and amaze. We gathered for a rather wonderful day behind the scenes at Williamson's Tunnels, then seeing Egyptian Art Deco high above the river before heading deep under the Mersey in the darkest reaches of the Queensway Tunnel.

## **Liverpool's Underground network**

Due to the closure of Liverpool Lime Street mainline station, all participants travelling by rail came into the much quieter Liverpool South Parkway and transferred to the Merseyrail underground network – 'the other Northern line'.

A short section of underground network consisting of two main lines and six underground stations, the



*Looking down the original line of the 1930s Mersey tunnel, originally planned as a tramway, now home to nine large refuge rooms. Photo Clive Penfold*

Merseyrail Underground has been in service since the 1880s. Running through the 1886 Mersey rail tunnel as a Birkenhead tunnel link, the underground network is usually a surprise to visitors used to the above-ground main line.

Coming into Liverpool Central station on the 1892 low-level platform, the similarity to London's Underground



is marked, despite different branding and signage. Added to the then twenty-year-old above-ground station, the platforms at Central are the terminus of two lines, Northern and the Wirral Loop. Served by staircases and lifts, the platforms at Central are currently considered to be rapidly reaching capacity.



*Liverpool Central station on the Merseyrail.  
Photo Bob Richards*

This led to a feasibility study in 2017 as to whether the disused Wapping / Edge Hill tunnel (visited by SubBrit in 2012) could be reopened. This would allow for the Northern line to extend through to Edge Hill.

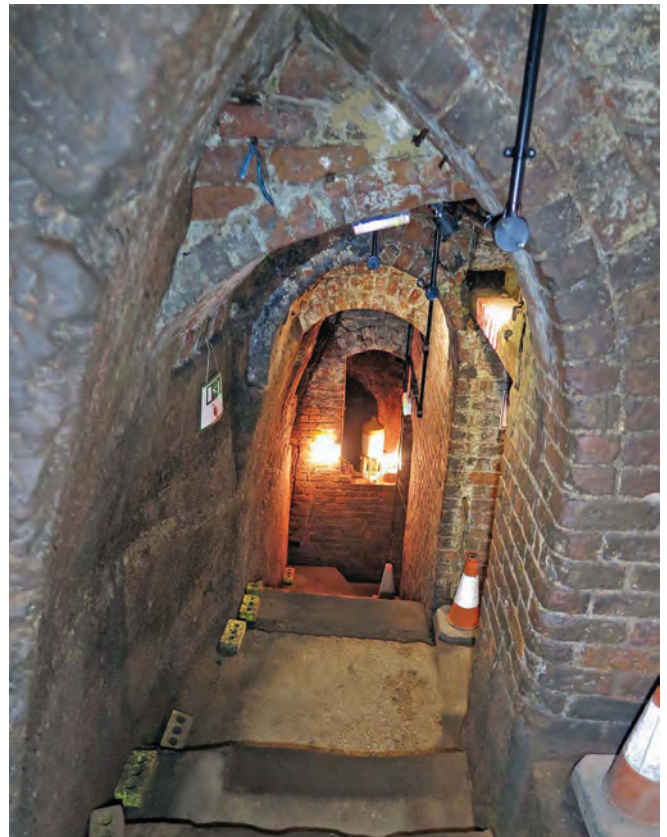
The Northern platforms replaced existing infrastructure for the Central low-level station whereas the Wirral Loop platforms are deeper, accessed mainly by lifts. The Wirral loop was closed on the day we visited, or would have made a great end to the day as a round-trip ticket covers all six underground stations and two tunnels under the Mersey.



*Heading into the Paddington complex of tunnels.  
Photo Phil Catling*

**Williamson’s update: Paddington**

Meeting at the Williamson’s House site, we quickly split into two groups and the first headed off to view the Paddington site, now empty of rubble. This was a big change for the visitors who had last come on the 2012 weekend, as shown in the recent Williamson’s update (see *Subterranea* 44, April 2017).



*Multiple arches and detailed brickwork revealed as SubBrit head down into the tunnels. Photo Clive Penfold*



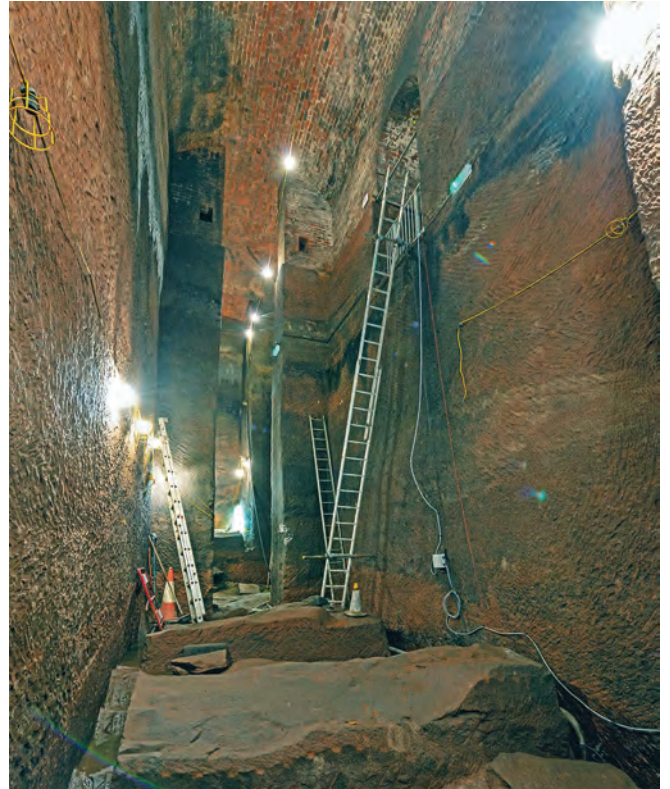
*Listening to the guide explaining the depth of ash and rubble excavated in this chamber – far above the group’s heads, and there was another two storeys below!  
Photo Clive Penfold*

Viewing the myriad of items found in the rubble and rubbish that filled the tunnels, we saw some strange sights. Chief among the finds were an intact fire extinguisher grenade and an early banana baby bottle, which our guide kindly informed us was almost certainly fatal for the majority of children who used it!

We were lucky to have expert guide Chris Iles with us for the day so we were able to visit all levels of Paddington, including the suspected reservoir with its sixty-foot ceiling. This involved a trip down the rickety scaffolding staircase into the depths, long past where the general public could go. Chris kindly waited until we had descended before telling us of the recent flooding in that area.



*Hand carving marks on the sandstone walls of the reservoir chamber, with detailed brickwork above.  
Photo Clive Penfold*



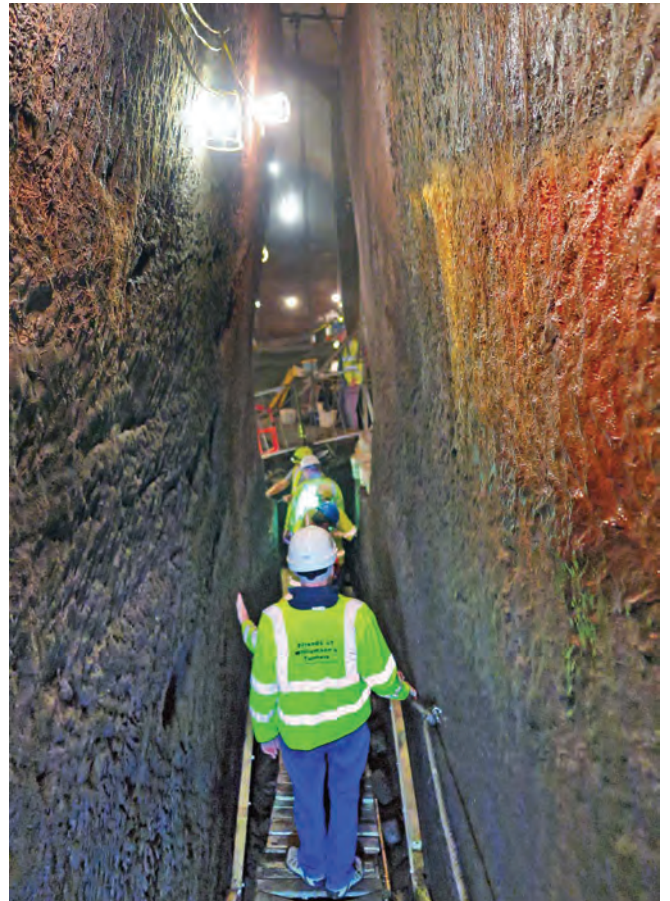
*The reservoir chamber showing its full height, along with the complex access required to reach the bedrock floor.  
Photo Friends of Williamson's Tunnels*

**Williamson's update: Mason Street**

The Mason Street site, on the other hand, bore almost no resemblance to the area last visited in 2016. The



*The temporary scaffolding staircase down into the reservoir, with the rubber boat required when it flooded not long before SubBrit's visit! Photo Clive Penfold*



*SubBritters descending the 'Gash' into the Banquet hall.  
Photo Clive Penfold*

Friends of Williamson’s Tunnels have worked wonders on this area, which when last visited was a car park and rubble store with a small access to the Banqueting Hall chamber. Since completing the emptying of Paddington, FoWT have concentrated all their considerable efforts into excavating here.

Unlike the Paddington area, a large amount of the work here has been opening chambers just under the surface, leading to a huge open dig where visitors can walk through the cellars of Joseph Williamson’s mansion. Mixed in with industrial units relating to the reuse of the area as a garage are wine bins, storage cellars, kitchens and the footings of a magnificent bow window. It is hoped to keep these open to the public to illustrate how Williamson linked his tunnel network with his mansion and other properties.

**Army rations**

Interestingly there is much evidence of the use of the remains of the house as a military barracks after Williamson’s death. Just before Sub Brit’s visit, a set of Officers’ urinals and a large cooking range had been uncovered. With the redevelopment of the waste ground in the adjoining plot, it is hoped that more military remains will be uncovered. These will shed light on the military use of the tunnels and may even identify the location of tunnels known to have been mapped by the Army in the 1880s and now lost.

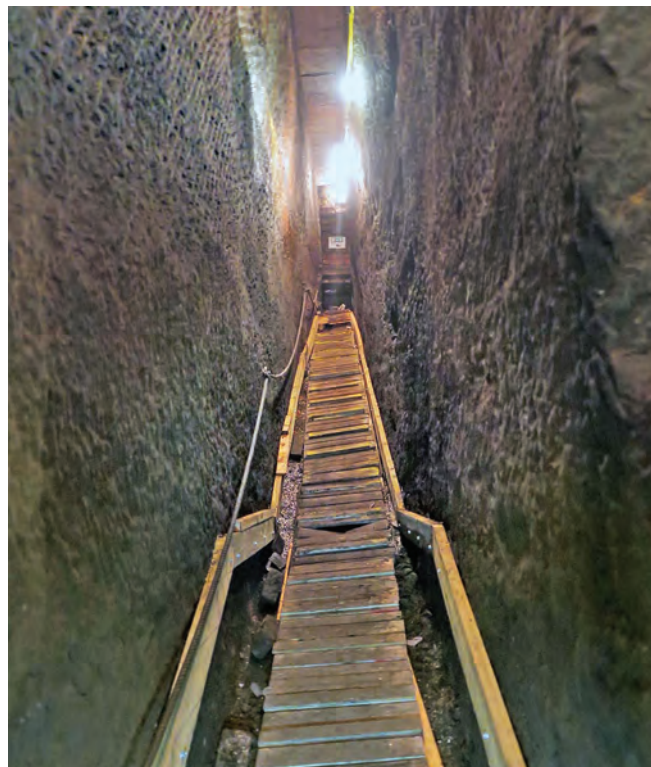


*The military cooking range uncovered beneath the tarmac at Mason Street. Photo Clive Penfold*



*Officers’ urinal block – other ranks would have used much more basic facilities nearby. Photo Clive Penfold*

Heading deeper into the Mason Street tunnels, we walked with ease into the ‘Gash’ once accessed by fall-arrest harnesses and a recovery tripod. In process as we visited and since completed, a new set of steps now lead down the Gash and into the Banqueting Hall. Like Paddington now empty of rubble and rubbish, it was a weird feeling to look high overhead at the brickwork.



*The temporary duckboard path leading down the ‘Gash’ since replaced with a purpose-designed set of steps. Photo Clive Penfold*



*SubBritters in the Banquet hall; this area was deep below a mound of rubble when last visited in 2012. Photo Clive Penfold*

On our last visit we were able to stand atop a huge pile and actually touch the bricks which now soared fifty feet above. Sub Brit were given access to all areas and were even invited to stick our heads in the latest find – a small tunnel choked with rubble that leads off in the direction of the Great Tunnel.

Each SubBrit member was given strict instructions not to come back above ground without bringing at least one brick or piece of rubble for the skip, which gave each of us a sense of pride in helping – although in a very small way! As always we were treated like VIPs by the lovely team at FoWT and paid a stunningly small donation for our visit. We made up by buying a wide range of postcards and pin badges as souvenirs.

### The Mersey Tunnel

After a quick lunch in the sunshine where most of us watched the launch of the RRS *Sir David Attenborough* across the Mersey and visited the memorials on the Liverpool Dock waterfront, it was time to head high into the sky and back in time for an Egyptian trip.



*Top secret WWII fighter planes being transferred across the Mersey through the tunnel, safe from German bombing.*

*Photo Mersey Tunnel Tours*

Visitors to the Mersey Tunnel tour start at the magnificent St George's Dock building, built in 1927, that soars over the nearby 'Three Graces' of the Cunard, Port of Liverpool and Liver buildings. It was built without windows as one of only three 'Egyptian Art Deco' designed buildings in the UK. (The other two are a cinema in Sale, Manchester – now a branch of Sports Direct, and the Carreras Cigarette Factory in Camden, north London, converted to offices in the 1960s.)

The tower is lit at night in a variety of colours and is a great directional landmark when you get lost in the nearby Liverpool One shopping complex. The outside of the building is Portland stone carved with Egyptian reliefs and statues, while on the piazza nearby stands an original 1920s tollbooth.

An interesting few minutes can be spent trying to work out which side of the building had to be restored after a German bomb blew the frontage off in the Liverpool



*The George's Dock building, showing the above ground levels. Photo Clive Penfold.*

Blitz. The design of the building is deliberate, basically a huge chimney to remove the toxic exhaust fumes and draw in clean fresh air for the tunnel.



*The Mersey Tunnels guides explaining the cross section of the tunnel. Photo Clive Penfold.*

As we entered, two enthusiastic guides from Merseytravel were there to greet us, forewarned of the sometimes difficult SubBrit mentality of 'just having a wander'! Suitably fitted out with high-vis and using our own helmets – a source of much hilarity from the guides – we set off, not downwards but up into the higher reaches of the building.

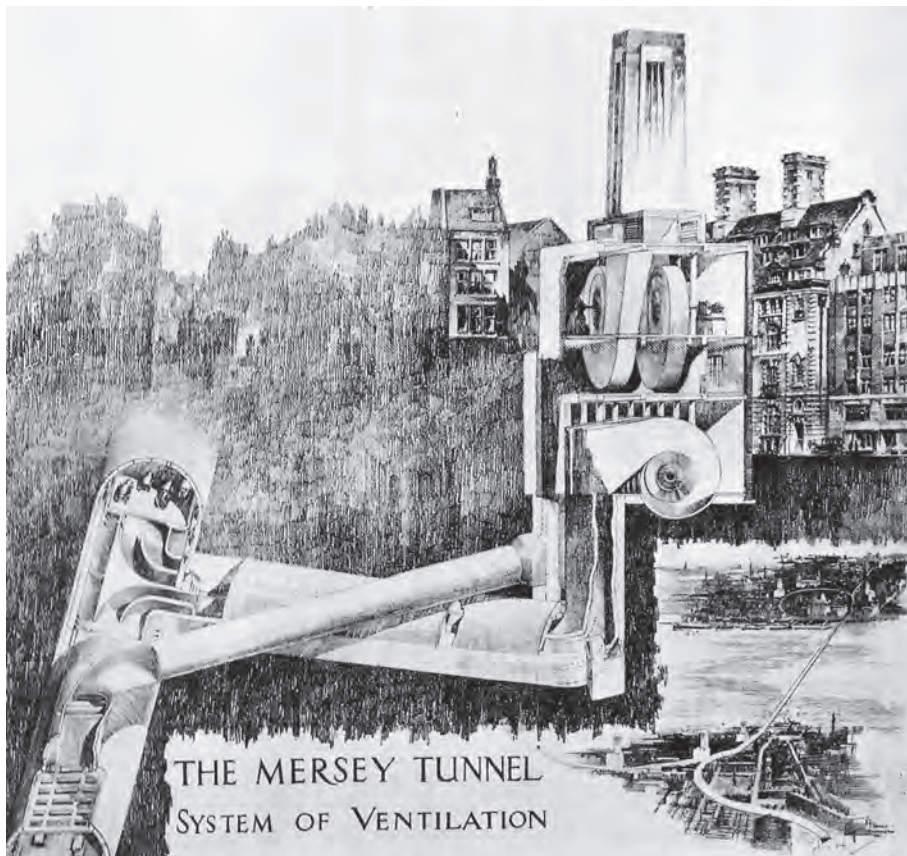
### The Control Room

As the tower building only has a tiny lift, the majority of the group started up the countless stairs and soon reached the landing outside the multi-million-pound Control Centre. This is responsible for the ventilation, traffic control and safety of the 90,000 vehicles a day which use the two Mersey tunnels.

The two tunnels (Queensway and Kingsway) have their own detachment of Merseyside Police and are unique in the North West as the officers are trained as both Police







*Cutaway diagram of the ventilation system showing relative depths.*

*Photo Mersey Tunnel Tours*

and Paramedics. Being located so close to the tunnel mouth, officers can reach an accident or incident within minutes, with one recent incident being reached within seconds!

Unfortunately due to the current high threat level, we got no further into this area but I'm reliably informed it looks like a modern office, with a lot of CCTV monitors, radio dispatchers, a few laptops and a kettle. With no time to be sad at this, we headed up again into the top of the building, where the original 1928 control room, filled with equipment from the 1930s on one side and the 1960s on the other, awaited.

First surprise was entering through a large airlock door – these were at every access point throughout the building and testified to the power of the fans pulling exhaust fumes from the tunnel and pumping in clean air. The guides told us that it was possible to be pulled completely off your feet by the suction – a dangerous thing on a stairwell or by the deep vents.

The guides gave us a blisteringly fast tourist history of the tunnel and its stats, leaving lots of time on the rest of the tour for more complicated SubBrit questions. As both guides were senior Merseytravel engineering staff, working extra on a Saturday, these were fielded mostly with ease.

The room itself was split evenly between the Deco style of the original build, with skylights, large mahogany counters and bakelite telephones, and a huge bank of 1960s grey electrical cabinets, buzzing with noise

and lights. All this equipment was still live, having only recently been replaced with the laptop in the lower control room. This led to a couple of stern glares as wandering hands pressed buttons.

Also in the control room was a large model of a 1930s tram, double-deck with a direction board reading Birkenhead. This was there to illustrate the original reason for excavating such a huge tunnel. The current roadway was originally designed to have a lower deck, built in to the bottom half of the round tunnel.

The lower deck would have allowed trams to pass from Liverpool to the Birkenhead side of the river quickly and quietly, without interfering with the flow of car and lorry traffic. This plan came a cropper almost immediately as it was quickly realised that the lower deck was needed for ventilation rather than for an already declining tram service.



*A closer look at the 1930s ventilation and control boards.*

*Photo Clive Penfold*

### **Fans and ventilation**

Heading out of the control room, we started our downward spiral, passing through the first of the large airlock doors and down to the 'shoulders' of the St George's Dock building. These shoulders are in truth the outlet vents for huge fans. The fans, built in the 1920s, are used to draw exhaust fumes, pollution and foul air from vents above the tunnel roadway.

The areas containing these were black with soot and dust from the cars and any touch meant pitch black fingers for the rest of the trip. The guides radioed through and we were treated to a test run of one of the massive fans. We had to grip tightly to railings and columns as the air was sucked from the vents and past us in a whirl – so noisy that no words could be heard.



*The view deep into one of the two vent shafts, coated in thick carbon pollution. Photo Clive Penfold*

This was only one of four original fans in the building, two for venting and two for clean air. After the fan was run, we were allowed to peer down into the huge vent shaft, leading straight down to the tunnel road bed and also black with dirt and soot.



*The 1930s engine to run the huge fans that pull foul air and fumes from the ceiling of the tunnel, to be vented through the high chimney of the building. Photo Clive Penfold*

Out through the air locks we went, heading down again to reach street level; here was a strangely similar set-up, with two large fans, huge moving metal doors and lots of industrial gantries. The major difference here was that this area was much cleaner, with no soot or dirt to be seen. These fans pulled fresh clean air from the open chimney at the top of the building, high above the ‘shoulders’ venting dirty air.

The fresh clean air was pumped down below the roadway itself, creating a positive pressure in the lower half of the tunnel. Small vents in the kerbs at each side of the roadway then released the clean air into the roadway in a controlled way. In the case of a spillage or fire, the positive pressure could be increased to force the dangerous air up and out through the overhead vents.

As we travelled through the ground floor and sub-basement we were treated to the sight of two massive 1960s fans, totally automated and installed as emergency backups. These run under the piazza at one side of the

building and can be seen above in the form of a wide shallow circular roof. Looking like something from a supervillain’s lair, we were glad to leave this area and move on further under the ground.



*A massive 1960s automated fan, pulling clean fresh air into the tunnel, coming up through the tunnel kerbstones.*

*Photo Phil Catling*

### **Bridge Room**

Before heading for the tunnel itself we were treated to a rare sight, the area known as the ‘Bridge Room’. Our guides led us from the 1920s concrete through a small door to be surrounded by instantly recognisable Victorian brick. We found out that the building wasn’t called St George’s Dock for fun; it actually – along with the Three Graces – stands on a Victorian bridge, one of three spanning the huge St George’s Dock itself.

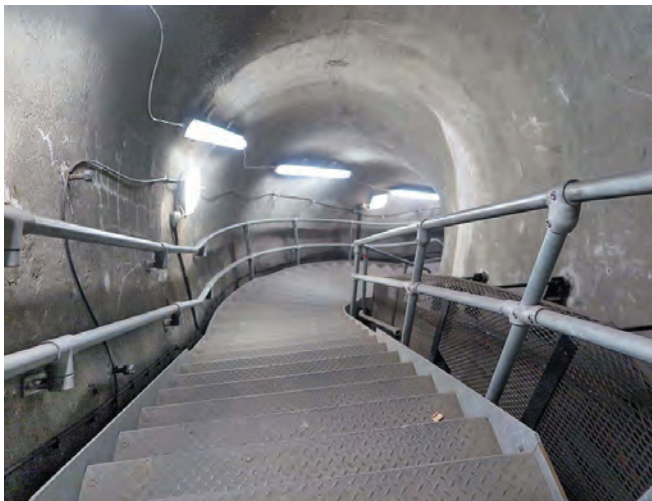


*SubBriters looking through the access hatch at the Victorian arches spanning the original George’s Dock.*

*Photo Phil Catling*

Dug in the 1760s the dock was redundant by the 1870s when the adjoining St George’s Basin was filled to create a new pier head. Three large bridges were built to span the dock, roughly in line with the streets now visible above. As the building which is now St George’s was constructed between the bridges, it is possible to view the abutments and even look through and hear the river below.

## Tunnel – Roadway



*Hundreds of steps, winding down under the river to the tunnel level.*

It was finally time to descend through the emergency stairwell and see the reason we were here – the tunnel itself. This unsurprisingly meant a lot of stairs, sobering when you realised they were going to be seen again on the way back up. This was reinforced by signs everywhere warning anyone with heart or health problems to use the emergency lift.



*After hundreds of steps, SubBritters about to enter the roadway through the emergency exit doors.*  
*Photo Phil Catling*

Like most emergency escape route areas these days, the route to the roadway was white, brightly lit and full of cables. With lots of green signage and helpful diagrams of how deep and how far under the river we were, it was interesting to see, and familiar to us all as experienced SubBritters.

Split into small groups, we were allowed out onto the emergency gantry by the roadway. We were warned in advance that the lanes were only nine feet wide, and a standard Transit van with wing mirrors was ten! On a Saturday afternoon the traffic seemed very light compared to similar tunnels, but I'm sure that is very different in rush hour.



*Watching vehicles fly past from the emergency exit platform, trying not to drop hard hats in the roadway.*  
*Photo Clive Penfold*

We were able to see the exhaust vents in the ceiling of the tunnel and the forced fresh air vents in the kerbs with ease. After surprising a few drivers who weren't expecting to see people on foot, we headed back into the escape tunnel for the next stage of our visit.

## Tunnel – Refuge spaces



*The new refuge spaces deep under the roadway.*  
*Photo Phil Catling*



*SubBritters looking at the original 1930s tunnel wall, now used to funnel clean air into the roadway.*  
*Photo Clive Penfold*

As the final airlock door was opened, the blast of forced air was remarkable; the whole lower deck of the tunnel was over pressured constantly, giving a large reserve of air that could be pumped into the roadway in an emergency. Back in the grime and dust, we soon felt at home, especially as we headed deeper and into the areas at either side of the lower deck.

Used for running cables and utilities across the river, these spaces also hold a gantry walkway. By now, our guides were experienced and watchful as Sub Brit's tendency to wander had been noted! With humour and patience the two guides made sure everyone got to see all the different areas of the tunnel safely.

We moved off down the gantry to see a relatively new area in the tunnel itself. Until the 1999 Mont Blanc Tunnel fire, the central section of the lower walkway was open through the length of the tunnel, with a Heath Robinson-style movable platform to check the condition of the roadway above.

In an emergency, drivers were told to stay with their vehicle or head for the surface by the nearest stairway. Not much use in mid-river. Refuge spaces and doors were rated (like Mont Blanc) for two to four hours, which was thought to give enough time for emergency services to reach anyone trapped.

The fire at Mont Blanc burned for 53 hours, destroying everything in its path and killing 39 people, many by the toxic smoke released in the tunnel, but one firefighter was killed and another fourteen were seriously injured as they awaited rescue in the refuge spaces.

## Fire precautions

Learning from the tragic lessons of Mont Blanc, the tunnel safety plan was reviewed in 2000. Restrictions were put in place on what could be transported through the tunnel, with certain loads and chemicals restricted to special convoys. The area under the roadway was surveyed for long-term refuge spaces, designed to allow huge numbers of trapped drivers and passengers to shelter in nine large purpose-built rooms, with first aid, blankets and basic food and water supplies. Each shelter also has basic toilet facilities.

We were brought down and allowed to visit one of these shelters; while basic, it was a lot better than what would have been happening above. While crowded and frightening, each refuge is equipped with communications between the control room, emergency services, and importantly, each other, so that supplies and resources could be shared.



*Modern safety signage showing the new refuge rooms, built deep in the tunnel after the Mont Blanc disaster.*

*Photo Phil Catling*

We, of course, considered this the ideal place for our official SubBrit group photo. After leaving the refuge, we were able to look along the lower level of the tunnel and take as many photos as we liked before heading for the stairs back to the surface.

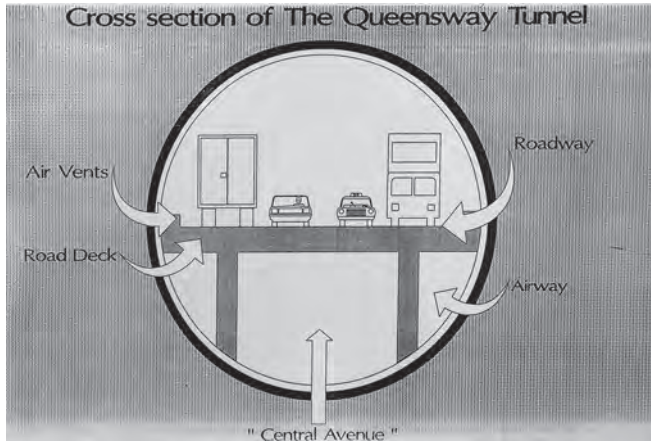


*The group photo. Photo Phil Catling*



## Conclusion

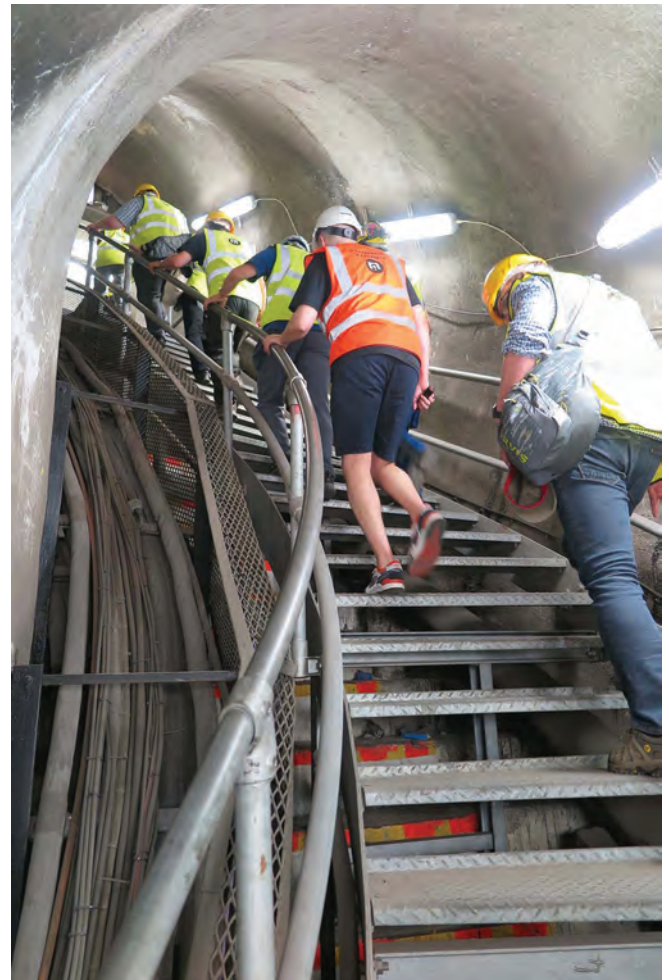
Our day out in Liverpool was a great success, with the warm welcome from the FoWT, and being looked after very well by the experienced guides at St George's Dock, who were very patient with wandering SubBritters. Seeing the upper levels, machinery and fans in use at the tunnel meant that the 'icing on the cake' of the lower passage and the tunnel itself were put into context brilliantly.



*Mersey tunnel cross section. From Mersey Tunnel Tours*

As always, FoWT were excellent at explaining such a complex site and their enthusiasm and love for their quirky tunnel network shone through. As we each donated £5 to FoWT and the Mersey Tunnel tour was remarkably cheap at £6 each, the day came to an incredible £11 per head.

We could even have fitted in a further visit as the tunnel tour was finished by 4pm. On the next one I hope to add a guided tour of the world's first dock, deep under Liverpool One, and a round trip of the six stations on the Liverpool Underground. Next trip is planned for summer 2019 so keep a close eye on the Events forum for further details.



*Heading back up to the surface. Photo Clive Penfold*

As always, a huge thankyou to the guides and volunteers at FoWT and Merseytravel who came in on a Saturday to share their sites with us. Each of them went above and beyond (or below and beyond?) the call of duty to ensure we had a fantastic visit. Lynn Mills and Chris Iles at FoWT deserve a special thank you.

## Distribution in space and time of mined gunflint

Flint was of course mined from the Upper Chalk, especially at Grimes Graves in Norfolk, in prehistoric times, around 2,500 years ago, for the manufacture of arrow-heads, axes, and the like. It is also known that flint was mined for use as gunflints, especially around Brandon in Suffolk, during around four centuries from the sixteenth century onwards.

This very durable material, so useful for the creation of edge tools and weapons before the discovery and use of metals, was distributed very widely, far beyond the few places in England where it was indisputably mined (West Sussex is amongst a handful of other counties with known flint mines).

After metals superseded flint for tools and weapons, the stony material (much less carefully mined, selected or shaped) continued to be very useful for the generation of sparks, and thus flames and fire, in tinder-boxes. The word tinder was in use in documents from at least as early as AD 700 although 'tinder-box' is first recorded only in 1530. Archaeological evidence having a bearing on this use of flint in scarce.

After the introduction of gunpowder to the British Isles, and the use of firearms, the mining of flint enjoyed a renaissance, as sparks made by it could fire the powder. And the British military bought huge numbers of gunflints which played their part in appropriating foreign lands to the Empire, and keeping the native populations of those lands 'under control'.

British gunflints (along with others manufactured in some other chalk districts in mainland Europe) found their way to sites hundreds and thousands of miles away. Being a virtually imperishable material, all these gunflints are still lying where, once blunted, they were discarded. Different shapes and sizes are known. A recent paper examines gunflints found in archaeological contexts as close to home as the Isle of Lewis in the Outer Hebrides, and comments on the terminology and typology of these artefacts.

SOURCE: BALLIN, Torben Bjarke, 2012, 'State of the art' of British gunflint research, with special focus on the early gunflint workshop at Dun Eistean, Lewis. *Post-Medieval Archaeology* 46(1), 116 – 142.



# Geevor Tin Mine revisited, Cornwall

Ken Geddes



*Victory Shaft head. Photo Ken Geddes*

In around 1990, Sub Brit had a study weekend based on Morwellham Quay in Devon. This was essentially a mining history weekend as the port was developed to support the local copper and arsenic mines. It has now been developed further into a major historical tourist attraction.

During the weekend, a coach trip was made to a major Cornish tin mine: Geevor. This was at Pendeen, on the north coast of Cornwall. The mine had recently ceased production due to the worldwide crash in tin prices but was still on a “care and maintenance” status. Sub-Brit members were shown around many of the surface features and encouraged to climb down the series of ladders to the third stage and exit through the adit onto the cliff.



*Looking down Victory Shaft from level 3 in 1995. The shaft is flooded up to the level of the drainage adit. The water level in the shaft remains the same today.*

*Photo Nick Catford*



*Victory Shaft – ladders led down to level 3 in 1991. This is now blocked off. Photo Ken Geddes*

It was hoped that investment money would be found shortly to develop new areas with potential, so that mining could recommence when prices recovered. Sadly, this did not happen but with the lobbying and work of the local organisation Pendeen Community Heritage and with the support of the Cornish County Council, the site was made accessible to the public.

Meanwhile, the National Trust had taken over the adjoining Levant mine. There is a pleasant one-kilometre walk along



the cliffs from Geevor to Levant, notorious for the failure of its man engine in 1919, killing 31 men and boys.

The area around what is now Geevor was mined for tin and copper in the late eighteenth century and was then known as East Levant, changing to North Levant in 1840. It closed in 1891. It had as many as 176 workers in the 1880s dropping to just a handful after “official” closure.

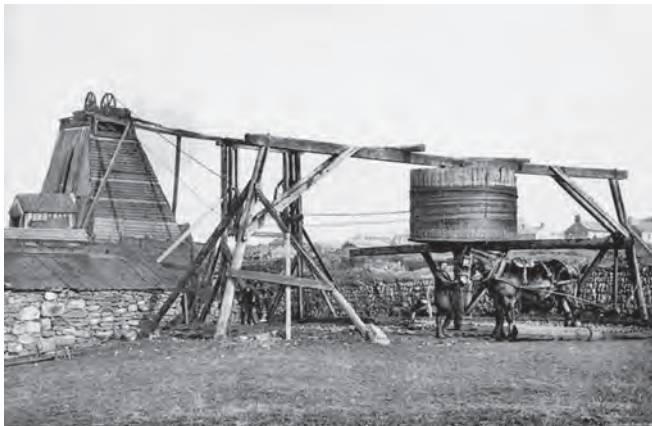


*The drainage adit in the cliff face in 1991. The adit is at a slightly lower level 3 in Victory Shaft. The adit is now securely gated. Photo Nick Catford*

### Price rise brings resumption of mining

Mining was restarted at the beginning of the twentieth century by a group of St Just miners who had been forced to leave South Africa at the outbreak of the Second Boer War. They set up Levant North (Wheal Geevor) in 1901. The price of tin increased in 1906 to £181 a ton from a low of £64 in 1896. By 1922 the group of mines was renamed Geevor Tin Mines Ltd.

The Wethered Shaft was the initial centre of activity for the Geevor Mine in 1909, production starting in 1911. Ten years later, work moved closer to the coast by 540 metres and the Victory Shaft was sunk in 1919. This is a 17ft x 8ft rectangular shaft, divided into three compartments; the ladder section also containing compressed air and water pipes as well as electric cables.



*Horse whim at Geevor. Photo Ken Geddes*

Work at the mine was suspended in 1921 and again in 1930 during the “tin crisis”. The Wethered shaft was

abandoned in 1944. After the war, skilled miners were difficult to find and Polish and Italians were recruited.

### Deep mining is hot work

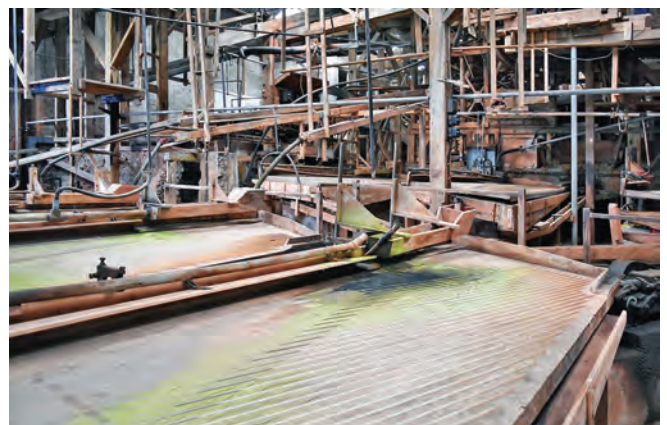
Rising tin prices in the 1960s encouraged new investment and underground development which included extending into the undersea workings of the Levant mine, closed in 1930. This involved the Victory Shaft being deepened and the driving of the Victory Shaft sub-incline, to reach Levant. This was at 2,130 ft (650 metres) depth and coolers had to be installed as the ambient temperature rises by 1°C for every 100 metres of depth.

This work was complicated by a hole in the seabed at Levant which first had to be plugged before the workings could be drained. Also, the long abandoned Boscawell Downs mine was dewatered and its main shaft, Treweeks, refurbished. This allowed access to the rich Simms Lode to the east. To match the mining side, ball mills were installed with new separation tables, capable of processing 100 tonnes of ore in a day.

However in October 1985, the International Tin Council failed and tin prices fell to a third of their previous value. Production of tin was halted and most of the staff laid off. The next year prices recovered somewhat and limited production restarted.



*Victory Shaft. Photo Woody Tyke*



*Separation tables. Photo Ken Geddes*

Although the mine was refinanced in 1988, Geevor struggled on until 1990, when production finally ceased.

In 1991, pumps which drained over a million gallons of water a day from the mine's sett of around three square miles, were switched off.

There are still deposits of tin which could be mined, but not economically. Geevor's total twentieth-century production was around 50,000 tons of black tin (Cassiterite/tin oxide/SnO<sub>2</sub>; 65–70% tin) from an eventual 100 miles of tunnels. However, over its working lifetime in the twentieth century, it made a profit of over £7 million.

**Tourist attraction and UNESCO recognition**

Geevor Tin Mine is now a museum and heritage centre, covering an area of 67 acres, which makes it the largest preserved tin mining site in Great Britain. It is an important part of the Cornwall and West Devon Mining Landscape which was recognised by UNESCO as a World Heritage Site in 2006. In all, there are more than 200 engine houses still standing over the Cornwall mining area.



*Victory Shaft cage controls. Photo Ken Geddes*

Geevor was purchased in 1992 by Cornwall County Council and has since had a £3.8 million programme funded by the Heritage Lottery Fund, Cornwall County Council and Penwith District Council.

Fortunately, key equipment was saved by the County Council purchase and in August 1993 the newly formed Trevithick Trust was appointed to run the site for tourists. During site restoration, Wheal Mexico mine was rediscovered and the opportunity taken to make this into a “visitor experience”. Subsequently, in 2010, the underground route was extended.

Visitor numbers increased but the Trevithick Trust became financially unviable and the management passed to a new charitable trust, Pendeen Community Heritage. Following the 2006 decision to give the Cornwall and West Devon mining area the status of a World Heritage Site, a major grant was received from the Lottery. This allowed refurbishment of buildings and the setting-up of the Hard Rock museum.

**New museum at Geevor with underground tour**

Geevor's new Hard Rock museum is part of the final stage of the improvement programme. The museum tells the

story of tin mining in Cornwall and Geevor in particular, showing what happened on the surface and underground – and what life was like for those who worked there.



*The newly opened mining museum. Photo Ken Geddes*

Visitors can walk through the mine buildings to see the original ore separation machinery. There is an underground tour into Wheal Mexico, a nearby mostly manually driven eighteenth-century mine. Typically of small independent mines, no original plans have been found. The site has a souvenir shop and a cafe that overlooks the sea.

Geevor superficially looks as I remember it, except for better access roads and car parks. More of the processing plant can be seen than when we visited some twenty years ago and other areas are now open. It was only possible to see, but not access, the first three ladders down which we had climbed to the third stage and out at the adit.

The Victory shaft is big despite its depth of 1,575 feet and is divided into three. Ore was taken up in one section, men went up and down in another and the third was for the series of ladders and sub-stages. After exiting through the adit, which comes out on or near the cliff, it was a bit of a climb back up as there seemed no path.

We walked to Levant on the Sub-Brit visit but on this visit drove round to Levant as there is now a separate car park and entrance charge to this site. The ticket office lady contacted the man in charge of the beam engine to ensure that it was still in steam.







*The walk-in entrance to Wheal Mexico, rediscovered in 1995 after removal of waste in preparation for the heritage site at Geevor. Photo Casper Tilly*

A disappointment and obvious embarrassment for the staff was that the shaft itself was now inaccessible as it is behind locked doors. One of the hinges had failed and they had been unsuccessful in sourcing a period replacement. Nor could they obtain a reproduction.

All agreed that it was a “baby and bathwater” Health and Safety situation but that seemed to be the rules for listed buildings (and mine shafts). As there is not much else apart from the shaft and engine on-site to justify the entrance fee, hopefully this situation will soon be rectified.



*Levant beam engine. Photo Ken Geddes*



*Eimco shovel 'Jack' and other underground equipment. Photo Ken Geddes*

## Empire Jack, World War I tunneller, of Mole Cottage, Mickleham, and Wonham Manor, Betchworth, Surrey

One of the more colourful combatants of World War I, Lt. Col. Sir John Norton-Griffiths [1871 – 1930], lies buried in the quiet country churchyard at Mickleham (near Dorking) in Surrey, and is the subject of two pages of biographical details in a booklet on sale in the church. Born John Griffiths in Somerset on 13 July 1871, he commenced a career in mining and civil engineering at the age of 17 in Australia. From there he went to South Africa, and saw action in the Matabele and Boer Wars, 1896 – 97 and 1899 – 1902. His first family home in Surrey was at Mole Cottage, Westhumble, an outlying hamlet in Mickleham Parish. In 1910 he was elected MP (Conservative Party) for Wednesbury, and later served also as MP for Wandsworth, serving in the House of Commons (when not abroad) until 1924.

His claim to fame, for Subterranea Britannica purposes, was his success in persuading the British War Office to establish military tunnelling companies to tunnel under the German lines to emplace explosives. Later in the war he was sent to Romania to destroy the oilfields, and almost singlehandedly destroyed 70 refineries and 8,000 tons of oil which might have fallen into German hands.



After the war ended in 1918 he bought Wonham Manor, at Betchworth, and in the 1920s was engaged in a project to raise the height of the Aswan dam in Egypt. Following disputes and the prospect of bankruptcy he appears to have committed suicide, his body being found in a small boat a short way off the coast at Alexandria on 21 September 1930. He was returned to Mickleham and is buried in the churchyard of the Parish Church of St. Michael and All Angels.

SOURCE: FULLER, Carole Brough, 2010, St. Michael and All Angels Church (Listed Grade II\*), Mickleham, Surrey. A short guide to St. Michael's Churchyard. Mickleham: St. Michael's Church: 52pp [2014 reprint]

# National Westminster Bank, Chard – Underground Bombproof Vault

**Nicholas Gould**



*Main entrance to the bunker at the back of the rear walled garden of the bank. Photo Clive Emmerson, auctioneer*

In 1938 construction of a massive underground concrete bombproof bunker began in the garden of the Westminster Bank branch in Fore Street, Chard, Somerset. It was built partially on the site of a tennis court by Sir Robert McAlpine & Sons and was finished in August 1939. Its purpose was to store duplicate copies of the bank's customer records, in case their headquarters at Threadneedle Street in London was destroyed by a German bomb.

The emergency supply of bank notes for the Bank of England was also held here until 1943. There is some speculation that the Crown Jewels were also stored here during World War II, although this has never been confirmed.

## **Bank closure**

The now Grade II-listed three-storey National Westminster Bank building dating from c1820 (built as two houses) has recently been closed as part of the bank closure programme and the premises, still complete with bunker, were put up for auction. A number of viewing days were held and I was able to view and produce this short report on what remains of the bunker.

The bunker is located at the rear of the garden of the Bank, with access also available from the rear of the Combe Street car park; the site is overgrown. On the surface is a one-storey blockhouse with steps up to the roof which lead on to the car park. The blockhouse is of brick construction and has a reinforced concrete roof slab. The structure is substantial and from looking at the thickness of the wall, it would appear that the red-brick exterior is merely a facing brick to this reinforced structure.

At the car park entrance is a metal gas-tight door which

provides access to the blockhouse. The main entrance was within the walled garden of the Bank. The entrance contains a store room to the left, with the entrance to the bunker itself. The entrance door is a black steel gas-tight door with locking wheel. The stairwell whilst wide has narrow steps and these dog-leg to get down to the main vaulted area. The walls have a two-tone colour scheme which you would associate with buildings of that era.

At the bottom of the stairs is a plant room with ventilation plant to one side. The plant looks to have been updated at some point due to the machinery being of more modern appearance than the ductwork within the main vault. There is an airlock with two black metal doors, again with metal locking wheels.

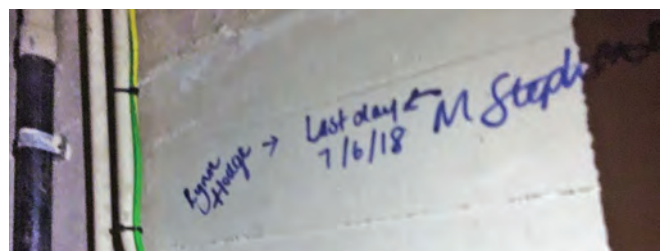
## **Secure Bank vault**

You then enter the main vault which is substantial in size. It is one large vault similar in style to the large vaults at the Bank of England or other City institutions. It is dry and well ventilated. The vault has good head height and has pillars every two metres or so. The floor is concrete with some form of tile; the pillars, walls and ceilings also have a tile cladding. Some of the tiles have started to separate from the ceiling and there is wooden batten which appears to be holding many of the tiles in place.

The vault has its original light fittings, wall sockets and other electrical connections, all of which are surface mounted in conduit. There is metal, cream-painted ventilation trunking throughout the vault. At the far end of the vault is a wooden kitchen sink unit served by a cold water tap with waste discharging to a drain. There is no mechanical method of dealing with the waste water and so it is assumed this discharges by gravity to some form of sewer.

## **Recent graffiti**

At the far end of the vault is an almost identical airlock. However, the doors have been retrofitted with more modern 'dogs' to secure the closure of the door. There is again a separate plant room with modern ventilation



*Last day graffiti near the rear entrance to the bunker.  
Photo Nicholas Gould*





*The vault with pillars every two metres.  
Photo Clive Emmerson, auctioneer*

plant and electrical switchgear. There is graffiti from 2018 indicating that NatWest Bank staff had accessed the vault on the day of the Bank's closure.

Within the vault there was no indication of toilets, washing facilities or standby power. The ground floor surface buildings were not accessible, and it would suggest that toilet facilities, generator and ventilation stacks were located in this higher level of the structure.



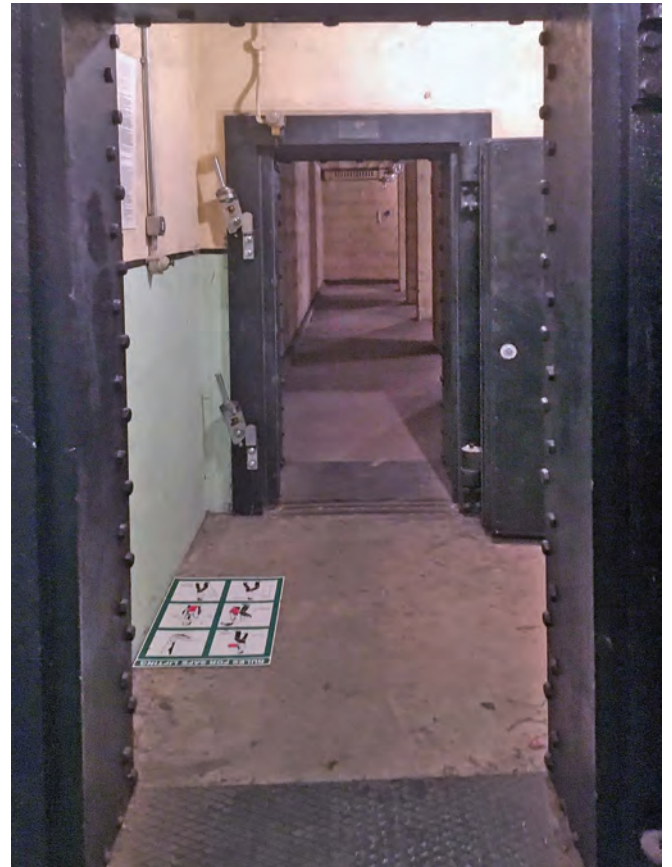
*1963 1:2,500 OS map. The bunker in the rear garden of the bank is highlighted yellow.*

The Conservation Officer of South Somerset District Council had been trying to access the site for a number of years prior, but the Bank had refused, stating that the vault was still in use. There is clear evidence that there has been some investment in upgrading ventilation and electrical plant.

The site was sold for £211,000, and we await with interest to see to what purpose the site, and in particular the bunker, is put.



*The entrance to the bunker at the rear of the walled garden. The first door is a store room with the gas-tight door into the bunker beyond. Photo Nicholas Gould*



*Air lock at the bottom of the entrance stairs. This is one of two air locks; each has two black metal doors. The bank vault is through the air lock. Photo Nicholas Gould*

# Missiles in the Great Plains

A tour of former missile sites in the northern USA

Alex Gould



*The Missile Site Control Building of the Missile Site Radar near the village of Nekoma, North Dakota.  
Interior view of level 4 showing three of the four antenna faces. Photo Chris Howells*

A small group visited the US in April 2018 in order to visit some of the former missile sites and bunkers associated with Grand Forks Air Force Base in North Dakota.

The focus of the trip was to view and document the sites which made up the Safeguard ABM (Anti-Ballistic Missile) system, namely the Stanley R Mickelsen Safeguard Complex (SRMSC), along with the Minuteman ICBM sites which it was designed to defend. The Sub Brit members on the trip were myself and Chris Howells.

## **A brief history of the SRMSC and the Safeguard deployment**

Safeguard was the name given to the first ABM system deployed by the USA. The system can trace its lineage back to the Nike SAM of the 1950s and was developed by the US Army. The original 1969 plan was to deploy the system at twelve sites across the US, defending both cities and ICBM fields.

The signing of the ABM treaty in 1972 limited deployment to two sites, one defending Washington DC and one defending an ICBM field. Ultimately only one site was completed, defending the Grand Forks 321st

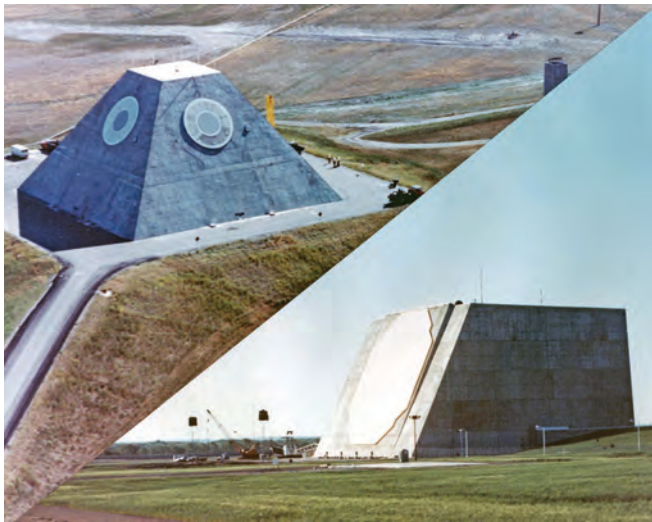
Strategic Missile Wing of 150 Minuteman silos.

Construction of the sites which make up the SRMSC began in 1970, and the system became fully operational on 1 October 1975. On 2 October, the US Congress voted to shut down the system, and tactical operations ceased in November 1975. Decommissioning began in February 1976, with the sites being salvaged and sealed by 1978. Due to the ABM treaty, the site was retained by the US military as it was the only site where they were allowed to deploy any future ABM system. Following abrogation of the treaty in 2002, the unused sites were sold at auction into private hands in December 2012.

The only remaining operational part of the Safeguard system is the Perimeter Acquisition Radar (PAR) which was transferred to the USAF and is now named EPARCS (Enhanced Perimeter Acquisition and Characterisation System) operated by the 10th Space Warning Squadron for ballistic missile early warning and space track.

## **An overview of the Safeguard system**

The SRMSC consisted of six sites. The first major site is the PAR. This had a long-range radar intended to



*The MSR turret 'pyramid' top and the PAR bottom.  
Photo provided by Clint Esciklsen*

detect incoming re-entry vehicles (RVs) as they crossed the North Pole. The PAR calculated RV trajectories and passed them on to the Missile Site Radar (MSR).

The MSR contained the iconic pyramid-topped bunker housing the radar and associated electronics required calculate intercepts, launch and guide the 46 interceptor missiles housed in the sites' silo field. In order to provide further protection, four Remote Sprint Launch sites (RSLs) were constructed 10 to 22 miles away from the MSR. The system was designed to protect an area of approximately 600 by 900 miles.



*Spartan missile on display in Langdon, North Dakota*  
Safeguard utilised two types of interceptor, Spartan and Sprint. There were 30 Spartan and 70 Sprint missiles, numbers being limited to a total of 100 by the ABM

treaty. Forty-six of these missiles (30 Spartan and 16 Sprint) were located at the MSR site, while the remaining Sprints were located at the RSLs.

Spartan was a three-stage solid fuelled missile weighing 29,000lbs. It was 55 feet in length and 43 inches in diameter. The missile had a range of 460 miles and was armed with a five-megaton W71 thermonuclear warhead. It was intended for exo-atmospheric interception of enemy RVs prior to their re-entry into the atmosphere. The cone-shaped Sprint Missile was a two-stage solid fuelled missile weighing 7,500lbs. It was 27 feet in length and 54 inches in diameter at its base. It had a range of 25 miles and was armed with a 20-kiloton enhanced radiation (Neutron Bomb) warhead. Sprint was intended to perform close range 'Terminal' interceptions of RVs which had eluded the Spartan interceptors once they had re-entered the atmosphere. In order to do this, Sprint was capable of speeds up to Mach 10 and accelerations of up to 100G.



*Sprint Missile on display at the Air Defence Artillery Museum, Fort Bliss, Texas. Photo Ron Plante*

The warheads on the interceptors were intended to kill incoming RVs not with heat and blast, but rather by generating an intense burst of radiation which would 'fizzle' the enemy warheads and prevent them from producing a useful nuclear yield.

### **Day 1: A Sprint start**

Following an interesting journey featuring blizzards and diverted flights, we arrived in Langdon, North Dakota to commence the tour. The first day was devoted to the RSLs.

The Safeguard RSLs consist of a 35 to 50-acre plot. Each RSL contains a guardhouse, a 12,000 square foot bunker referred to as the RLOB (Remote Launch Operations Building) and a Sprint missile silo field containing between 12 and 16 Sprint launch cells. The sites are located between 10 and 22 miles away from the MSR. Our first stop was RSL 2. The current owners of RSL 2 live in the guardhouse and use the RLOB for storage and for the operation of their business which makes miniature models. We started with a tour of the topside structures beginning with the guardhouse. This had been modified for accommodation, but still retained the security desk and turnstile. Next stop was the Sprint silo field.



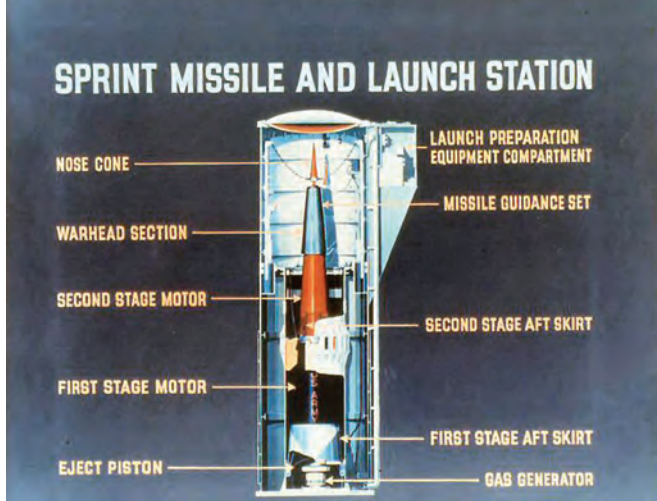
*Pads for RLOB AC condensers foreground, air intake shaft left, exhaust stack right*



*RSL 2 Silo field with 12x Sprint launch cells*

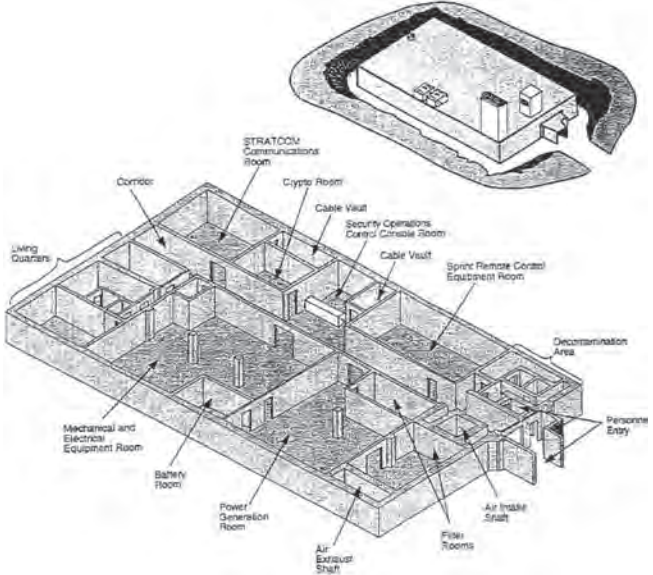
RSL 2 has 12x silos. These are cylindrical steel structures 32 feet deep and 9.5 feet in diameter. The silos are topped with a frangible cover which would have been explosively fragmented prior to the missile being launched.

From the mound, we headed into the bunker. The RLOB is a semi-sunken structure measuring 142 by 80ft in plan and 17ft tall. The bunker has 36 rooms and is entered via a sloping tunnel 77ft long. This ends in a pair of blast doors, equipment access ahead, with personnel access to the right.



*Sprint launch cell diagram. Provided by Clint Esciklsen*

Sprint was intended to be cold launched, with a solid fuel gas generator pushing the missile from its silo prior to stage one engine ignition. The current owners had not looked into their silos and suspect them to be full of water. The Spring field would originally have been surrounded by a double fence with its own guardpost. These were removed sometime during the 1980s. Next, we headed to the top of the RLOB mound. This area contains the inlet and exhaust towers for the bunker, along with the location of the condensers for the cooling systems. These had been removed during site salvage.



*RLOB Cut-away diagram. Provided by Clint Esciklsen*

We entered via the equipment entrance. This is made up of two large sliding blast doors creating a blast lock. The blast lock opens onto the spine corridor which runs the length of the bunker.



*RSL 2 RLOB main corridor*

On entering, we turned right and inspected the decontamination area and the personnel access blast doors. Next stop on the tour was the generator room on the left-hand side of the corridor. This would have held two gas-turbine generator sets along with motor generators and batteries to supply power to the site in the event of mains failure. This room was currently used as storage which made photography difficult, but it was possible to identify the generator beds and battery room, along with the air filtration rooms, of which there were two, one for generator combustion air, and one for HVAC use.

Next, we entered the ‘Mechanical and Electrical Equipment room’. This still contained three large air handling units, along with numerous machine beds and much overhead cable conduit. The last stop on the left-hand side of the spine corridor was the crew’s quarters. These were largely unrecognisable due to removal of all studwork partitions, but it was still possible to pick out the location of the bathroom and crew dormitory. Crossing over the corridor we entered the ‘STRATCOM communications room’ which originally contained the data and voice communication equipment for the site.

This room was interesting as the floor was shock mounted on large pneumatic cylinders. Following a brief look in the crypto room which still contained all of the (now empty) cryptographic equipment racks, we headed into the ‘Sprint Remote Control Equipment Room’.

This room is now used as the workshop for the owners’ model business, but originally it would have had two rows of racks containing the equipment allowing the monitoring and firing of the Sprint missiles via the command systems at the MSR. All of the rooms on the right-hand side of the spine corridor were lined with quarter-inch steel plate for EMP protection. This completed our tour of the bunker, so following a brief drive around the perimeter track we headed on to RSL 3. RSL 3 is the best preserved of the RSLs and still has all its fences and exterior lighting. Unfortunately, we were not able to view the interior of the site, so having taken some photographs through the fence we moved on to the PAR.



*The PAR bunker taken from nearest public road. PAR surface bunker to the left with the underground powerplant and its stacks on the right*

The Safeguard PAR (Perimeter Acquisition Radar) consists of a 128-foot-high surface bunker and a large underground powerplant. The bunker hosts the AN/FPQ-16 phased array radar which has a 2000-mile range.

The antenna face has 6888 antenna elements, each with a maximum output of 1.1Kw. As stated above the PAR is still in use by the USAF and is sadly not open to tours. Pushing on, we set a course down dirt roads for RSL 4. Unfortunately, this site was inaccessible so to complete the RSL tour, we headed to RSL 1. We started the tour of this site with a brief explore of the empty guardhouse before heading to the RLOB.



*RSL 1 RLOB entrance tunnel and stacks*

On entering the bunker, it was discovered that the site was flooded with two feet of water; however due to recent cold weather this was found to be frozen solid, leading to this author’s first experience of exploring a bunker on ice. The layout and condition of all the Safeguard RLOBs is identical so RSL1 will not be described in detail.

The fact that the site was empty did allow for better photography, and photos of the spine corridor and Sprint Remote Control Equipment rooms are shown here.

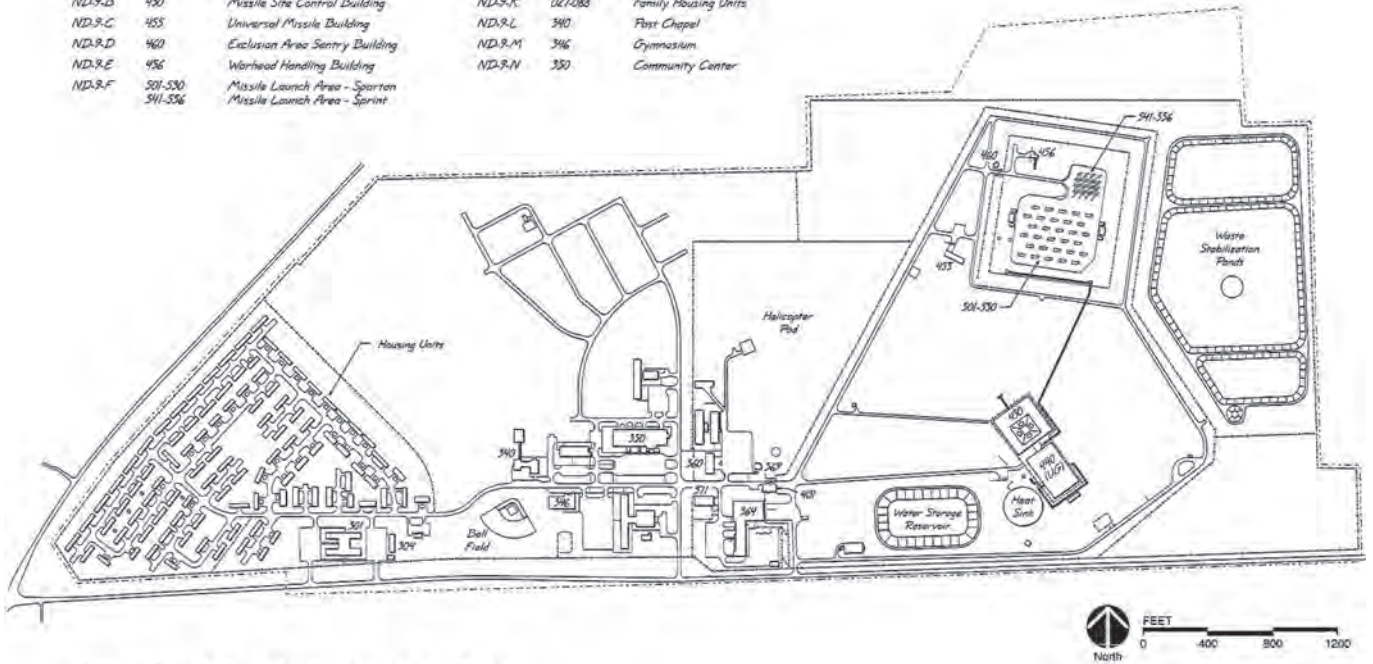


*RSL 1 RLOB Sprint Remote control equipment room with ice floor*



*RSL 1 RLOB frozen spine corridor looking towards open entrance doors. Photo Chris Howells*

HAER NUMBER	BUILDING NUMBER	BUILDING FUNCTION	HAER NUMBER	BUILDING NUMBER	BUILDING FUNCTION
ND-9-A	401	Limited Area Sentry Station	ND-9-G	369	Fresh Water Pump House
ND-9-AS	360	Administration HQ Building	ND-9-H	301	Installation Headquarters Building
ND-9-AT	371	Polar Telephone Building	ND-9-I	304	Area Engineer/Administration Building
ND-9-AU	440	MSCB Power Plant (US)	ND-9-J	364	Industrial Building
ND-9-B	490	Missile Site Control Building	ND-9-K	027-088	Family Housing Units
ND-9-C	455	Universal Missile Building	ND-9-L	340	Post Chapel
ND-9-D	460	Exclusion Area Sentry Building	ND-9-M	346	Gymnasium
ND-9-E	456	Warhead Handling Building	ND-9-N	350	Community Center
ND-9-F	501-530	Missile Launch Area - Spartan			
	541-556	Missile Launch Area - Sprint			



*Missile Site Radar (MSR) Site*

*MSR site diagram. Taken from HAER Survey document ND-9-B*

After a quick look around the Sprint silo field (12x launch tubes), we headed back to the hotel at the end of a very interesting first day of exploring.

### **Day 2: Missile Site Radar**

The Missile Site Radar (MSR) site is located outside the village of Nekoma, North Dakota. The site occupies 470 acres and consisted of a technical site and a large domestic site to service the sizable staff required to operate the system.

The technical site consists of two main sections, the Missile Support Area and the Missile Site Control Building (MSCB).

The Missile Support Area contains the Sprint and Spartan silo fields, two underground power supply bunkers, a warhead handling building and the 'universal missile building' which was used for missile preparation and maintenance. The MSCB area contained the MSCB bunker, the MSPP (Missile Site Powerplant) bunker, a heatsink for the powerplant and a diesel fuel storage area.

### **Missile Interceptors**

Our tour began with the Missile Support area. First stop was the warhead handling building.

This is a mounded surface building 35 by 43 feet in plan and 27 feet high. The building was empty apart from a five-ton overhead crane.

Next, we headed for the silo field. The area contained 16x Sprint and 30x Spartan silos.



*MSR warhead handling building exterior*



*MSR warhead handling building interior showing main door and overhead gantry crane*







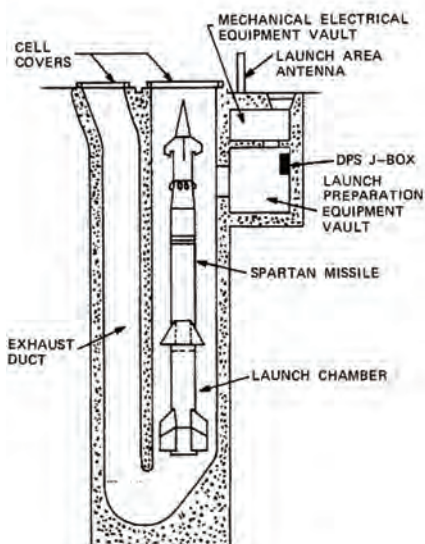
*Drone photograph of the Missile Support area.  
16x Sprint silos in foreground with 30x Spartan silos to rear.  
Photo Chris Howells*

The Spartan silos were 9 ft in diameter and 72 ft deep, the launch duct being inclined 5 degrees from vertical, pointing north.



*Historic photo of Spartan missile in its silo during installation. Provided by Clint Esciklsen*

There was also a J-shaped flame deflector and exhaust duct and an underground room containing launch support equipment for the missile.



*Spartan silo cut-away diagram.  
Provided by Clint Esciklsen*

Sadly, the Spartan silos were filled with gravel by the US Army in 2013 and are no longer accessible.

Following a brief inspection of the power supply bunkers, which were found to be full of ice, the next stop was the Universal Missile Building, a large earth mounded rectangular structure that was used to service the Sprint and Spartan missiles. Entry is via a truck dock, into a large room with an overhead gantry crane.



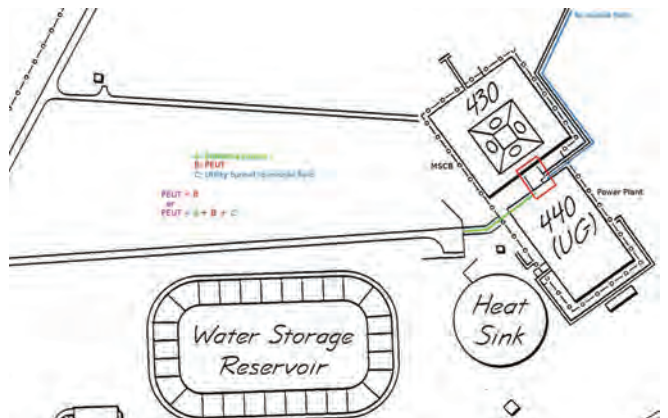
*Universal Missile Building interior*

The walls on either side of the room were lined with racks, and these still contained signs describing their function.



*Spartan maintenance equipment rack in Universal Missile Building*

Beyond the main room was a small complex of rooms used to store plans and parts for the missiles. As these were all empty, we moved on towards the main MSR bunker.



*Diagram showing the tunnels associated with the MSCB and MSPP bunkers*

The MSR bunker is the main building on the site, and is actually made up of two bunkers, the MSCB (Missile Site Control Building) and the MSPP (Missile Site Powerplant). These are loosely connected via the PEUT (Personnel Equipment and Utility Tunnel) which served as a connection between the two buildings.

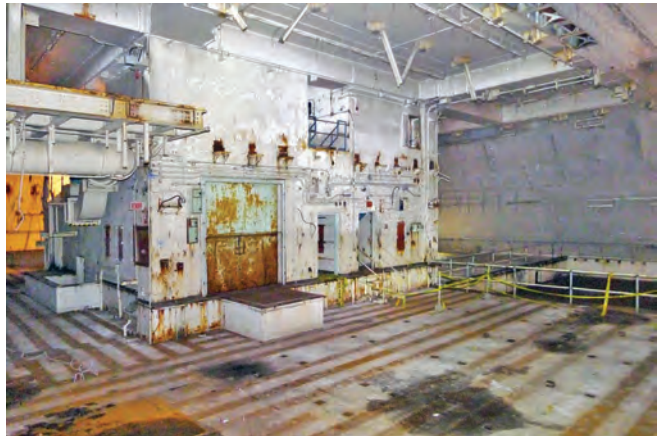
**MSCB**

We started with the MSCB. This has approximately 127,000 sq feet of floor space spread across four main levels, a basement, and two mezzanines, one above level 1, and one above level 3. Levels 1 and 2 are subterranean and measure 231ft square in plan, by 53ft tall with 3ft thick walls and roof. Levels 3 and 4 are in the pyramid-shaped turret. The turret measures 136ft square and is 79ft tall. Each face of the turret houses a phased-array radar antenna 13ft in diameter and containing 5000 array elements.



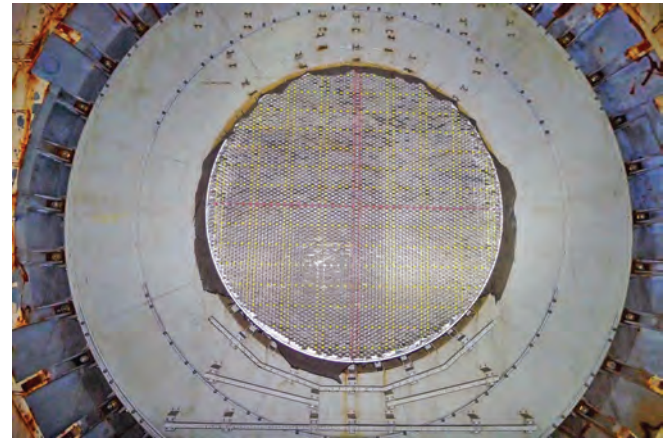
*One of the MSCB turret faces showing the radar antenna. The pipes protruding from the face are for the antenna washdown system used to clean or de-ice the antenna. The small antenna to the lower right is the 'Q' antenna which is used to blank the main antenna side-lobes*

Our entry point was the emergency exit located in the northeast face of Level 3. This level originally held the antenna electronics which would have controlled the operation of the radar antennas, along with a mezzanine containing the duplexers which allowed the use of the same antennas for transmit/receive. This level had been completely stripped of all equipment including the mezzanine floor and stairs to level 4 leaving a very large empty space.



*Interior shot of MSCB level 3*

From level 3 we moved on via a ladder to level 4, the antenna room containing the rear part of the four radar antennas. The area was originally divided into four RF chambers, one for each antenna face. These contained the antenna feed horns from which the microwave energy was space-fed to/from the rear of the antenna elements. The antennas are one of the few significant remainders of the radar system which were not removed at the time of closure.



*Present-day photo showing one of the antenna faces. The antenna elements are still in place, although the stainless-steel covers have been removed from around the antenna*

After lunch, our next destination was level 2, which contained the operations areas of the Safeguard system. This included the BMDOC (Ballistic Missile Defence Operations Centre) from which the system was controlled, the MSDP (Missile Site Data Processor) mainframe computer system along with communications, support and maintenance areas.

Having descended the stairs from level 3, we began our tour of level 2 in the microwave room. This room contained the waveguide switching system which allowed the single main RF source to switch between the different radar antennas. The room also has the microwave balcony which looks down over the remains of the two-storey Klystron room.



*MSCB level 2 main corridor. Photo Chris Howells*

Following the corridors via a very icy personnel entry blast door, our next stop was the MSDP area. The MSDP was the computer system which controlled all aspects of target tracking and interception by the

Safeguard system. The computer system was a 10-way symmetric multi-processing system capable of approximately 20MIPS (millions of instructions per second). The hardware was custom built by Univac and IBM and was probably one of the most powerful computers in the world in the early 1970s. To put this performance into perspective, a 1980s vintage 25MHz 80486 CPU is rated at 20MIPS.

The main part of the computer system was housed in the aptly named MSDP electronics area.



*Historic photo of the MSDP control area on MCSB level 2. Control consoles and status displays are in the foreground while some of the 'digital racks' which housed the components for the MSDP computer are to the rear. Provided by Clint Esciklsen*



*A contemporary photo of the same room. The previous photo was taken from against the rear right-hand wall. All equipment including the raised floor and cable mezzanine has been removed making for a very tall area*

As with most areas this had been thoroughly stripped of its suspended floor and cable routing mezzanine leaving a large empty room. Next door to the MSDP electronics area is the Tape Handler room. This would have contained the disk and tape storage for the MSDP

Following closure, this room was used by the US Federal Aviation Authority for testing bomb hardening of airport luggage lockers; the effects of this testing are still quite visible. From the tape handler room, we moved on to the BMDOC.



*Historic view of the Tape Handler room. Line printers are in the foreground. Hard disk drives to the rear left, and tape drives to the right. Provided by Clint Esciklsen*



*Present day photo of Tape Handler room. Note the damage to the ceiling and rear wall caused by FAA bomb hardening testing after site closure*



*Historic view of the BMDOC showing the four consoles during installation. The panels on the rear wall showed system status. Provided by Clint Esciklsen*

This was the nerve centre of the Safeguard system and contained 4x consoles for the launch crew. There was also a separate room overlooking the BMDOC containing a console for the installation commander. A large part of level 2 was devoted to HVAC and support equipment. These areas were thoroughly stripped out with no remaining equipment and are therefore not covered here.



*Contemporary photo of the stripped BMDOC. The raised floor and suspended ceiling have been removed*

Other highlights on level 2 included the COMCEN which still contained a shock mounted platform full of equipment racks.



*The crypto room, showing racks of communications equipment mounted on a shock isolated platform and the LAUT (Launch Area Utility Tunnel).*

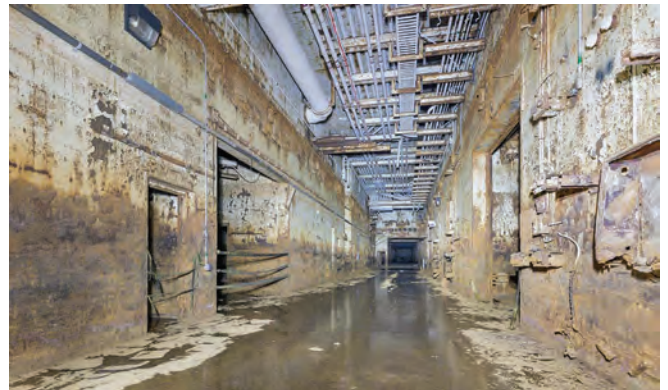
The LAUT connects the MSCB bunker to the Missile Support Area and was used to carry power and data cabling to the missile silos. This tunnel includes an impressive two-storey cable entry structure and a smaller cable tunnel which is sadly flooded to within 100ft of the cable entry vault.



*View of the LAUT. This section connects the cable entry structure with the PEUT further around the bunker*

The final part of the MSCB tour covered Level 1 and its mezzanine. The mezzanine level originally contained support equipment for the MSDP including power supplies and liquid cooling systems along with parts storage. Half of the floor area of level 1 contained the main parts of the radar transmitter and its support equipment while the other half was devoted to communications equipment cooling systems and storage. Both Level 1 and the mezzanine were flooded following site closure until being pumped out for environmental remediation in the late 1990s.

The tour of level 1 began in the truck-sized spine corridor. This provided vehicular access for the transport of large items of equipment along the whole length of the MSCB and MSPP bunkers.



*The level 1 spine corridor. This photo is taken half way down the tunnel in the MSPP looking into the MSCB in the distance. Photo Chris Howells*

As with most areas of level 1, this area was thoroughly stripped and heavily water damaged, but gave a good idea of scale of the MSCB/MSPP bunkers. From here we entered the Klystron room.



*Contemporary view of the Klystron room showing the microwave balcony above. The Klystron tanks would have been in the foreground of the photo*

This would have held the two Klystron valves which formed the final power amplifier for the radar .



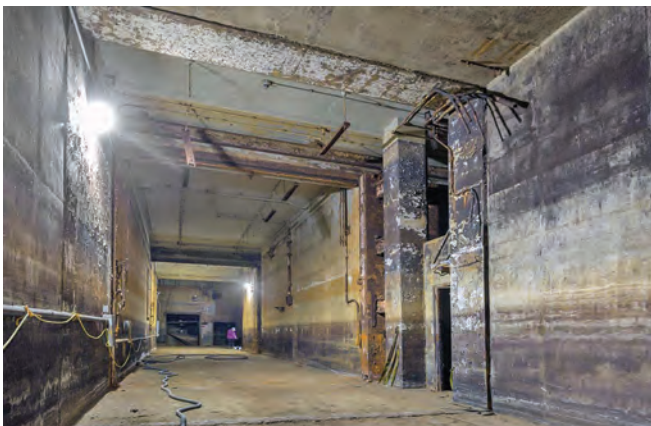
*Historic photo showing the Klystron tanks. This photo is taken from the opposite end of the room to the previous one. Provided by Clint Esciklsen*

We then entered the former transmitter control room followed by one of the high voltage power supply rooms which powered the Klystrons. All of these rooms were very well stripped to the point where interpretation would have been impossible had we not known what was here before. This area also had a basement below it, however this was unfortunately full of ice and therefore inaccessible to explore. We headed on towards the MSPP bunker via the PEUT.

The PEUT is a two-storey structure which joined levels 1 and 2 of the MSCB with levels 1 and 2 of the MSPP. The PEUT was not strongly connected to either bunker in order to allow for possible ground movement in a nuclear attack. The main function of the PEUT was to act as a cable entry point for both bunkers, while also allowing connection of cabling, plumbing and HVAC ducting between the MSCB and MSPP. From here we continued along the spine corridor into the MSPP.

### **Underground Powerplant**

The MSPP contained all of the equipment required to support the operation of the tactical systems installed in



*The vehicular blast-lock. The first of a pair of very large sliding blast doors is visible in the centre of the image. The entrance to the personnel blast-lock and decontamination suite is visible in front of the main blast door. The access tunnel is behind the photographer and the main spine corridor is in the distance. Photo Chris Howells*

the MSCB. It is spread across two subterranean levels and measures 301 by 179ft in plan and 32ft tall. The main part of the bunker was given over to 6x diesel generators. These were referred to as ‘Prime Mover Modules’ and consisted of 16-cylinder turbocharged diesel engines manufactured by Cooper-Bessemer. Each unit had an electrical output of 2.9megawatts.

The MSPP also contained HVAC equipment supplying both bunkers along with personnel accommodation and security facilities. Our tour began on level 1 at the main entrance to the underground site. This consists of a sloping vehicular access tunnel which ends in a blast lock with a pair of very large sliding blast doors.



*The interior of the personnel blast-block with a very rusty blast door*

These would usually have been closed when the site was operational, with personnel entering via a smaller personnel blast lock with a decontamination suite for use in NBC conditions. From the personnel entrance we toured the SOCC (Security Operations Control Centre). This area housed consoles for all of the security alarms and CCTV camera positions both within the bunkers and over the missile support area. Responses by personnel on the surface to any security incursion at the site would have been co-ordinated from here.



*Contemporary photo of the SOCC*

We headed on to the area which contained the generators. Each of the generators was housed in its own two-storey room.



*Historic photo of the SOCC looking in the same direction.  
Provided by Clint Esciklsen*



*Contemporary photo of prime mover module 4.  
The generator bed is clearly visible under the ice. The  
combustion air room is through the doorway at the far end  
of the shot. The inaccessible mezzanine level is also visible.  
Photo Chris Howells*



*Historic view of one of the prime mover modules.  
This photo is actually of an identical unit in the PAR  
powerplant. Taken from HAER Survey document ND-9-B*  
The generators had of course been removed when the site was decommissioned, but it was still possible to see where they were located, along with their control/switch gear. Each generator also had a ‘combustion air’ room

and an ‘exhaust muffler’ room. The six combustion air rooms are situated behind each generator room and were responsible for filtering intake air for the corresponding diesel engine.



*The combustion air room of prime mover module 4.  
Photo Chris Howells*

For the final part of the underground tour, we headed to level 2 of the MSPP. This area contained the main air filtration and HVAC systems for the bunker, the dispatchers room and the domestic facilities. We started with the HVAC areas. There were two main AC systems in the MSPP, with both being fed with fresh air from a single air intake stack. This area was surprisingly intact with extensive trunking and filtration units etc still in situ. Having had a look around, which included peering up the intake shaft, we moved on to the dispatchers room.

This room was completely stripped and empty, so we headed for the domestic rooms. This consisted of a rest room with a small kitchen a bathroom and dormitories for officers and other ranks. These rooms are surprisingly small given the number of people who worked in the bunker, however under normal circumstances personnel would have lived and eaten in the domestic camp, so the underground facilities would only have been used if the site was ‘buttoned up’ due to nuclear attack. This concluded the underground part of the tour, so we headed topside to view the heatsink and domestic site.

## Topside

The heatsink is a large circular water tank with a capacity of seven million gallons. The tank contained ethylene glycol, enough to allow for cooling of the MSCB and MSPP systems for up to three days with the bunker locked down in a nuclear attack scenario.



*Drone photo of the bunkers. MSCB with the turret in the background, MSPP in the foreground with the heatsink upper left. Photo Chris Howells*

The heatsink was found to be flooded to an indeterminate depth, so we did not venture inside the access hatch. There are various other tunnels around the MSPP which carried fuel and cooling lines. We located the access hatches to these, however unknown air quality and an overwhelming smell of diesel put us off venturing into these.

We inspected the outside of the MSPP including the emergency exit hatches and the massive intake/exhaust stacks



*The MSPP generator stacks taken from the top of the heatsink. The taller ones are exhaust with the shorter ones being intakes*

before moving on for a brief look around the domestic site which included a cinema, bowling alley, shops, gym and chapel. There were also married quarters and messes for officers and other ranks. Various buildings had been demolished over time, including the messes and medical centre, however the community centre with

shops, cinema and bowling alley is still extant, along with the gym and chapel.

This concluded an excellent day of exploring, so it was off to the only bar in nearby Langdon for the evening.

## Day 3: We meet the Minuteman

As stated above, Safeguard was intended to protect the 321st Strategic Missile Wing which operated the Minuteman ICBM. Minuteman is a three-stage solid-fuelled missile which came in three versions. The original Minuteman I was first deployed in 1962 and could throw a one-megaton thermonuclear warhead over a range of 5500nm (6329 statute miles).

An improved version, Minuteman II, was fielded in 1965 with a higher-yield warhead (1.2Mt) and more accurate guidance. The final version of the missile, Minuteman III, was the first deployed ICBM with MIRV (Multiple Independent Re-entry Vehicle) capability. It originally carried 3x warheads each with a yield of 170kt, with deployment beginning in 1970. The Minuteman III is the only member of the family which is still in use today.



*Minuteman III ICBM. This display missile is located in the Air Park at Grand Forks Air Force Base, North Dakota*

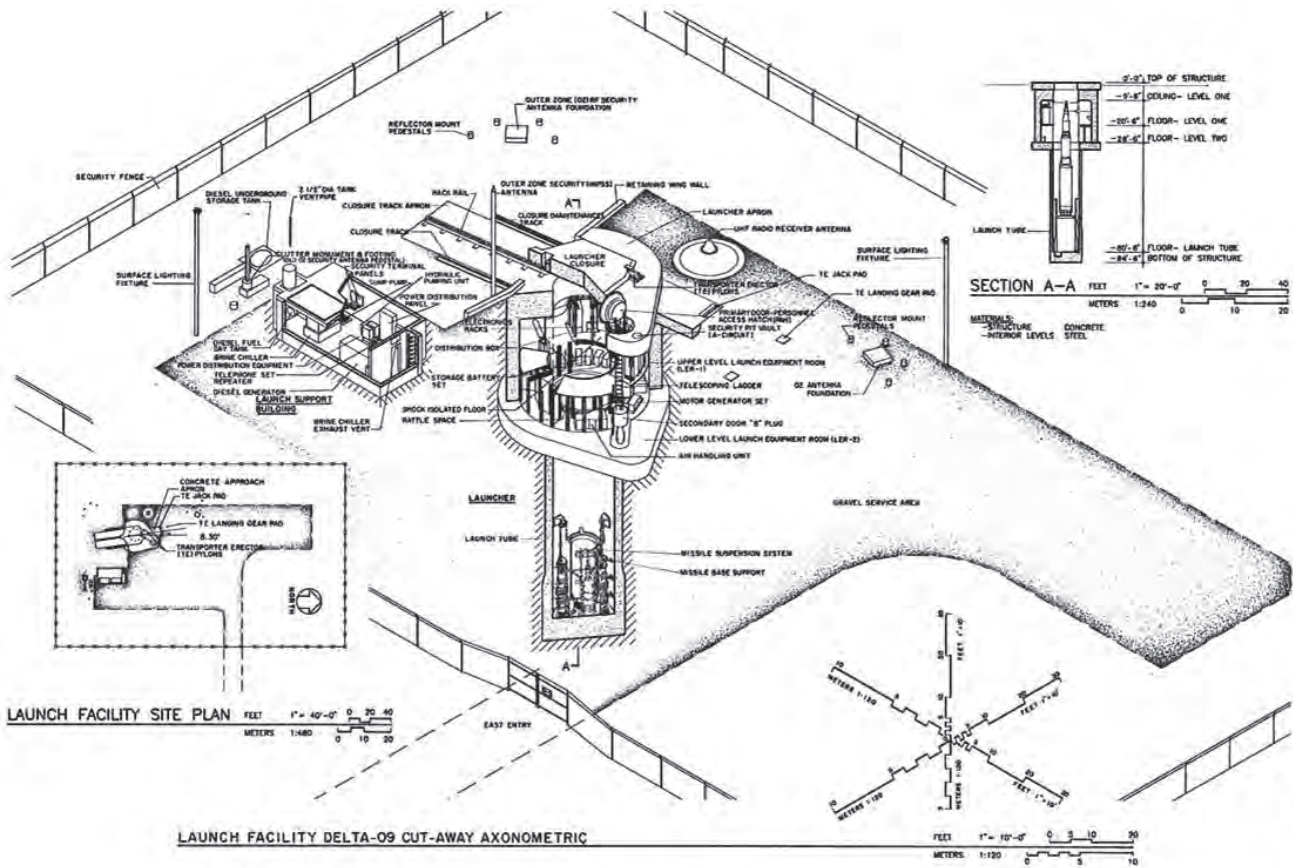
The US deployed a total of six Minuteman wings during the Cold War totalling 1000 missiles. Each Minuteman wing had between 3 and 4 squadrons with 150 and 200 missile silos (referred to as Launch Facilities or LFs) assigned to it. Each squadron had 50x silos, and these were broken down into flights of 10x with each flight having one MAF (Missile Alert Facility) containing a launch control centre (LCC).

The Minuteman silos were deployed on a highly dispersed basis with at least five miles between each one. The LFs are 80ft deep by 25ft wide and are capped by a 90-ton sliding silo door. The sites are hardened to withstand a blast overpressure of 300PSI.

Each flight of missiles had one MAF, with the LFs being unmanned in normal circumstances. The MAF consists of a topside building containing security and domestic facilities, and an underground LCC bunker.

There were three versions of the LCC design. The early sites (Wings I and II) had only a single underground bunker, with all support equipment such as HVAC and

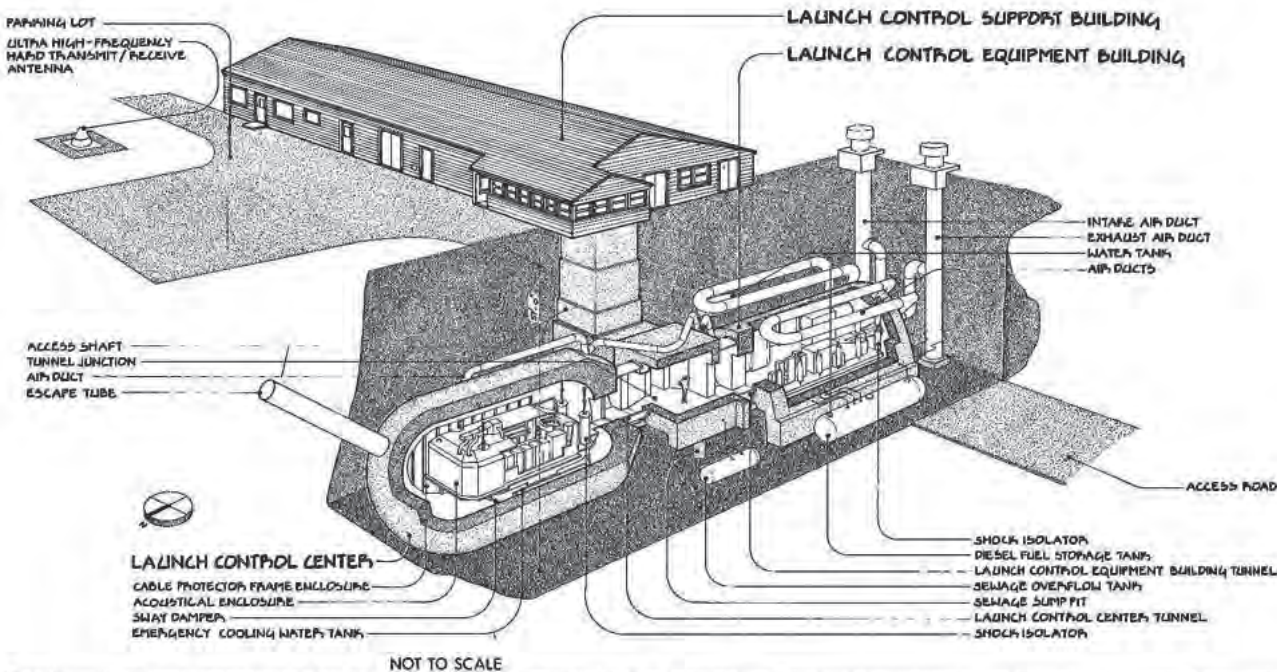




*Cut-away diagram of early Minuteman silo from wings I/II.  
Taken from HAER Survey document SD-50-C*

backup generators located in the surface LCSB (Launch Control Support Building). The LCC ‘capsule’ was hardened to withstand 1000PSI overpressure. Wings III-VI had an underground Launch Control Equipment

Building (LCEB) which was hardened to 300PSI, while the sites constructed for wing VI at Grand Forks had both buildings hardened to 1000PSI.



**PERSPECTIVE**

TAKEN FROM LAUNCH CONTROL FACILITY INSTALLATION DRAWING BY SCENIC, SEATTLE, 1962, AND MAP ISOMETRIC BY U.S. AIR FORCE, Ft. WARREN AIR FORCE BASE, 1964.

*Diagram of Minuteman MAF and LCC bunker. This diagram is for a Minuteman Wing III to V site such as those in Colorado. Taken from HAER Survey document CO-54*





## Ronald Reagan Minuteman Historic Site

Our first Minuteman site visited was the Oscar Zero MAF. This site was part of the 448th Strategic Missile Squadron (SMS) which was part of Minuteman wing VI (321st SMW) based at Grand Forks AFB. The 448 SMS was operational from 1965 until 1998 and initially operated Minuteman II missiles before these were upgraded to Minuteman III, starting in 1971. This particular MAF is now a museum and known as the Ronald Reagan Minuteman Missile Site.



*Exterior view of LCSB at O-0 MAF*

Our tour began in the topside LCSB. The LCSB contained the domestic facilities to support the operation of a flight of 10 LFs. Staff assigned here included the launch crew of 2x Missileers, 2x teams of 2x security police, a flight security controller, a facility manager and a cook. The domestic facilities included a gym, pool/tv room, a dining room, kitchen and bedrooms.

Having toured the domestic areas, the group headed to the Security Control Centre.



*View of SCC (Security Control Centre) at O-0 MAF*

This room would have been occupied by the flight security controller who controlled access to the underground portion of the site, while also dispatching security teams to any alarms at the ten unmanned LFs in the flight. From here we entered the lift which descends 50ft into the bunker below.

As mentioned, the bunker is actually two bunkers; the LCC and the LCEB are connected to the lift lobby by a tunnel junction with the LCEB on the right, and the LCC on the left. Our first stop was the LCEB which is entered by a massive 13 ton blast door.



*LCEB blast door*

The LCEB contains a diesel generator, electrical switchgear, air filtration facilities and HVAC systems required to support the operation of the LCC bunker next-door.



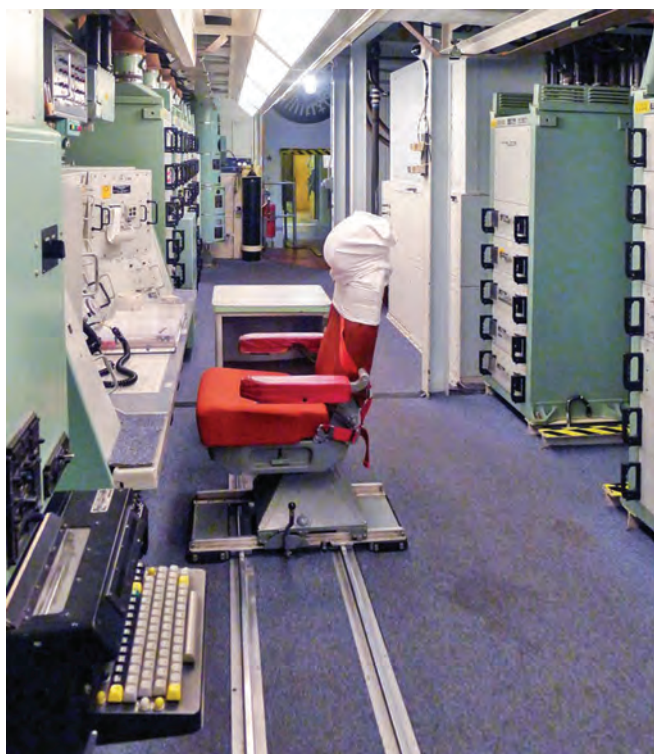
*LCEB Interior view*

All equipment is mounted on a shock platform which is hung from the ceiling on large pneumatic shock absorbers. The electrical switchgear is still in use and was buzzing away noisily during our visit. Having inspected

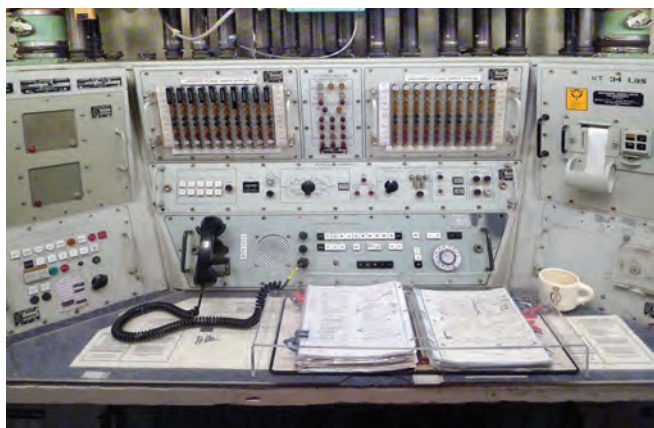
the LCEB we moved on to the LCC which is protected by another six-ton blast door. The LCC contained all the equipment required to monitor and launch the ten missiles in flight.

Each LCC could also monitor all 50 missiles in the squadron if required, thereby providing redundancy should any other the other squadron LCCs be taken offline. On entering the LCC we passed a small toilet and kitchen area, before passing into the ‘acoustic enclosure’ which is where the launch crew of two officers worked. As with the LCEB, the whole thing is hung from the ceiling of the bunker from large pneumatic cylinders. This would allow for movement in the event of a nearby nuclear blast.

The acoustic enclosure is filled with equipment racks along with the two launch consoles.



*LCC equipment racks with DMCCC launch console on left. The entrance to the acoustic enclosure is in the background*  
The first of these was for the DMCCC or Deputy Missile Combat Crew Commander.



*DMCCC launch console. The launch-enable key is on the lower right*

The console for the MCCC or Missile Combat Crew Commander is situated on the back wall of the room.



*MCCC launch console. Photo Chris Howells*

Both consoles have a launch-enable key, and these would need to be turned and held simultaneously to allow launching of the missiles. The consoles are positioned far enough away from each other to ensure that no one person could turn and hold both keys at the same time. The launch crew worked 24-hour shifts known as ‘alerts’ to allow for rest; during these periods a bed was provided so that one officer could sleep while the other monitored the missiles and communications. Oscar-Zero also has some interesting murals



*Mural. Photo Chris Howells*

This concluded our tour of the MAF. Our next stop was the N-33 LF.

All of the silos associated with the 321st SMW at Grand Forks were imploded under the START I nuclear disarmament treaty, with the demolitions running between October 1999 and August 2001. N-33 was spared demolition but was instead filled in with gravel leaving only the topside portions of the site intact.

Today N-33 forms part of the same museum as the Oscar-Zero MAF. Having had a brief look around the topside areas, we headed on to our next stop in Philip, South Dakota.

After an eight- hour drive we arrived at our hotel for the night, the *Missile Inn*. This B&B is located in the former C-1 Minuteman MAF which was part of the 44th SMW based at Ellsworth AFB in South Dakota. Unfortunately access to the former LCC bunker is thoroughly sealed. Following a good night’s rest and a hearty breakfast we headed on to our final destination of the trip.

**Day 4: The Minuteman National Historic Site**

The Minuteman National Historic Site is run by the US National Parks Service and consists of the preserved D-1 MAF and D-9 LF. As with the *Missile Inn*, these sites were both part of the 66th SMS which was part of the 44th SMW.



*A view up the personnel access shaft at D-9 LF*



*Topside view of N-33 LF.  
The silo is now sadly filled with gravel*

As with the 321st SMW, all of the LFs belonging to the 44th SMW apart from D-9 were imploded between 1994 and 1996.

Our tour began at D-9 which the National Parks Service had kindly agreed to open for us to visit the interior which is not usually open to the public. D-9 is one of the early Minuteman LFs (the 44th SMW was designated Wing II). It therefore only has a soft Equipment Building. This small subterranean building contains a diesel generator, HVAC ‘brine’ chiller and electrical switchgear which support the



*Personnel access hatch at D-9 LF. The hatch leads to a 25ft vertical shaft with a ladder for access*

operation of the equipment in the adjacent silo. Having had a brief look around the equipment building we headed topside in order to enter the personnel hatch of the launch silo. The personnel hatch at D-9 is hydraulically actuated and weighs approximately four tons.



*Silo equipment area level 1. Racks of launch support equipment are housed on a shock mounted platform*

We entered the two-level Launch Equipment room which surrounds the upper part of the silo. The upper level of the equipment room contains racks of launch control and monitoring equipment along with part of the pyrotechnic mechanism which was used to open the 90-ton silo door. The centrepiece of the site is of course the launch duct which contains the Minuteman II missile training ground.



*Minuteman II ICBM showing the re-entry vehicle at the top which would have contained the 1.2Megaton Thermonuclear warhead. The cable on the left is the electrical umbilical for the guidance system. Photo Chris Howells*



*A view down the missile silo showing all of the rocket's three stages along with the shock isolated thrust mount on which the missile sits. Photo Chris Howells*

The missile is mounted on a shock mount at the bottom of the silo and would have been hot launched, i.e. the first-stage motor ignited inside the silo. Unfortunately, level 2 of the silo was not visited due to health and safety issues, so having thoroughly inspected level 1, we headed back topside for some photos of the silo cap.



*Topside view of D-9 LF showing the greenhouse built to give visitors a view of the missile in the silo*

One of the stipulations of the preservation of the site under the START I treaty was that the silo door be blocked open to prevent reuse of the silo. In order to do this and also to allow visitors to view the missile a 'greenhouse' display structure has been built on top of half of the launch duct; this provides a good view down to the missile in the silo.



*A view of the Minuteman II ICBM training round in the D-9 silo*  
Having had a good look around the fairly sparse topside structures, we moved on to the other part of the museum at the D-1 MAF.

### **Tour of the D-1 MAF bunker**

The topside parts of D-1 MAF are very similar to those at the O-0 museum. The only major difference being

that all support equipment is housed in the soft surface building. This will therefore not be discussed in detail here, the main point of interest being the LCC bunker located 50ft below the MAF. The personnel lift arrives in a dogleg corridor which ends in a six-ton blast door with its iconic darkly humorous mural.



*The famous mural on the LCC blast door at D-1 MAF.  
Photo Chris Howells*

Ducking through the low opening of the door brought us into the LCC capsule. The capsule is much smaller than the one at O-0 and contains a small toilet along with the shock-mounted acoustic enclosure containing all the launch support electronics racks and the launch consoles.



*The interior of the D-1 LCC acoustic enclosure.  
Note how much smaller it is than that at O-0.*

As with O-0, the DMCCC console is first on the right, with the MCCC console at the far end of the room. The launch consoles are of a different design to the later ones we saw at O-0.

A bed and small kitchen area occupy the left-hand side of the room along with a large AC unit.

Having viewed the interior of the acoustic enclosure, we



*DMCCC console in D-1 LCC. This is an older design than those installed at O-0*

were led onto a narrow walkway which skirts the outside of the capsule in order to view the emergency exit.



*Emergency escape hatch in D-1 LCC. The hatch would be opened with a spanner via the nut in the centre of the hatch*

The emergency exit shaft would have been full of sand in order to enhance blast/radiation protection, and this would drop into the capsule on opening the door.

One wonders about the circumstances where this would be required as the crew would have to hope that the sand in the upper part of the shaft had not been turned to glass by a nearby nuclear blast. Furthermore, as all sources of power and air were located in the surface building the crew would realistically only be able to perform their work for a few hours on battery power.

This very much brings back the reality of the ICBM deterrent where missiles would be launched on warning of an enemy attack, at which point the launch crew's job was complete and they would have to fend for themselves if they survived the enemy strike. On this sobering thought we headed back topside and on to the excellent visitors centre at the conclusion of the tour.

The tour of the Minuteman National Historic Site concluded our Cold War tour of the Great Plains. We then embarked on the long drive back to the airport before flying back to the UK.

We would very much like to thank the site owners for access to the sites and the excellent and fascinating tours which they provided. Specific thanks go to Shannon

Duerr of the Cavalier County JDA for the tour of the MSR and also for helping arrange access to RSL 2. Also to Park Superintendent Eric Leonard and Ranger Matt Roland of the NPS for providing our bespoke tour of the Minuteman Historic Site facilities.

All photographs in this article are by the author unless otherwise credited.

### References:

#### Books:

Morgan Mark, & Berhow Mark. *Rings of Supersonic Steel – Air Defences of the US Army 1950-1979*: Hole in the Head Press, 2010

*Historic American Engineering Record (HAER No. ND-9-B and ND-9-AU)*: Library of Congress Prints and Photographs Division Washington, DC 20540

Berhow, Mark. *US Strategic and Defensive Missile Systems 1950-2004*: Osprey, 2005

LaForge, John. *Nuclear Heartland*: Nukewatch, 2015

#### Websites:

[www.srmssc.org](http://www.srmssc.org)

The resource on the internet for information around the Safeguard ABM system, with a wealth of photos and information on how the system worked, the locations involved and the people who worked on it. There is also an interesting section on the Minuteman system which it protected.

[www.minutemanmissile.com](http://www.minutemanmissile.com)

A site devoted to Minuteman and its development. Contains numerous drawings, photos and information about the sites and the squadrons which operate them.

## Practicalities of passing through canal tunnels

A guide to inland navigation (by both canals and rivers) in England and Wales, published in 1904, gives fascinating details of the practicalities of negotiating locks and tunnels. By 1904 the system included 45 tunnels over 100 yards long, of which ten were over 3,000 yards. The great majority had no tow-paths through them, and were very narrow at the waterline (insufficient to allow two craft in transit to pass), so a system had to be devised whereby two could not meet head-on underground. Most craft even as late as 1904 were still hauled by horses, which could not operate without a towing path. It seems the horses



*Legging through Greywell Tunnel on the Basingstoke Canal in 1913*

walked over the hill to recommence haulage at the far portal, or were exchanged for fresh horses as had been the practice in stagecoach days (a sort of horse version of the Boris bike!) In the place of horses to pull boats through, the men or women on board had to push. There were two ways to do this, 'legging' and 'shafting'. Legging called for the crew to push against the tunnel ceiling or walls with their feet. For some long tunnels, professional 'leggers' could be hired to do this. In shafting, the crew used long poles to push instead of their legs. Some shorter tunnels were equipped with iron chains hanging along one side of the tunnel, and the crew pulled on these to attain forward motion. Exceptionally, a stop-lock could be operated at one end of the tunnel to accumulate a head of water sufficient when released to cause a current in the required direction, which at least helped.

To avoid two craft travelling in a tunnel in opposite directions, an alternating timed one-way system was operated. Clearly, somebody had to be stationed at each end to regulate admission. A few tunnels by 1904 may have had telephone lines between the persons at each end. Only the latest tunnels such as Netherton, were wide enough for two craft to pass, and equipped with a path each side, and even gas lighting.

SOURCE: DE SALIS, Henry Rodolph, 1904, *Bradshaw's canals and navigable rivers of England and Wales: a handbook of inland navigation for manufacturers, merchants, traders, and others*, compiled after a personal survey of the whole of the waterways. London: Henry Blacklock & Co. Ltd: ix + 450 + 8pp adverts [A facsimile reprint was published in 2012]



# The Welbeck Abbey tunnels, Nottinghamshire

Paul W Sowan



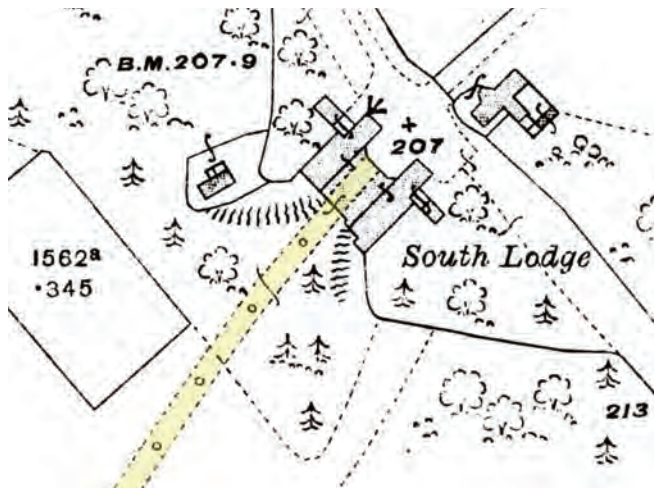
*The tunnel entrance at South Lodge at the north of the estate. Photo Peter Barr.*

*Reproduced from Geograph under creative commons licence*

The tunnels at Welbeck Abbey, near Worksop in Nottinghamshire, were noted briefly in the report of the 2018 Nottingham Study Weekend in *Subterranea* 49. They were created by William John Cavendish-Scott Bentinck, the fifth Duke of Portland [1800 – 1879] (he was not the fourth Duke as erroneously stated) between 1860 and his death in 1879.

## **Nikolaus Pevsner's account**

Nikolaus Pevsner and Elizabeth Williamson described the Abbey and the tunnels and underground rooms in *The Buildings of England* volume for Nottinghamshire.



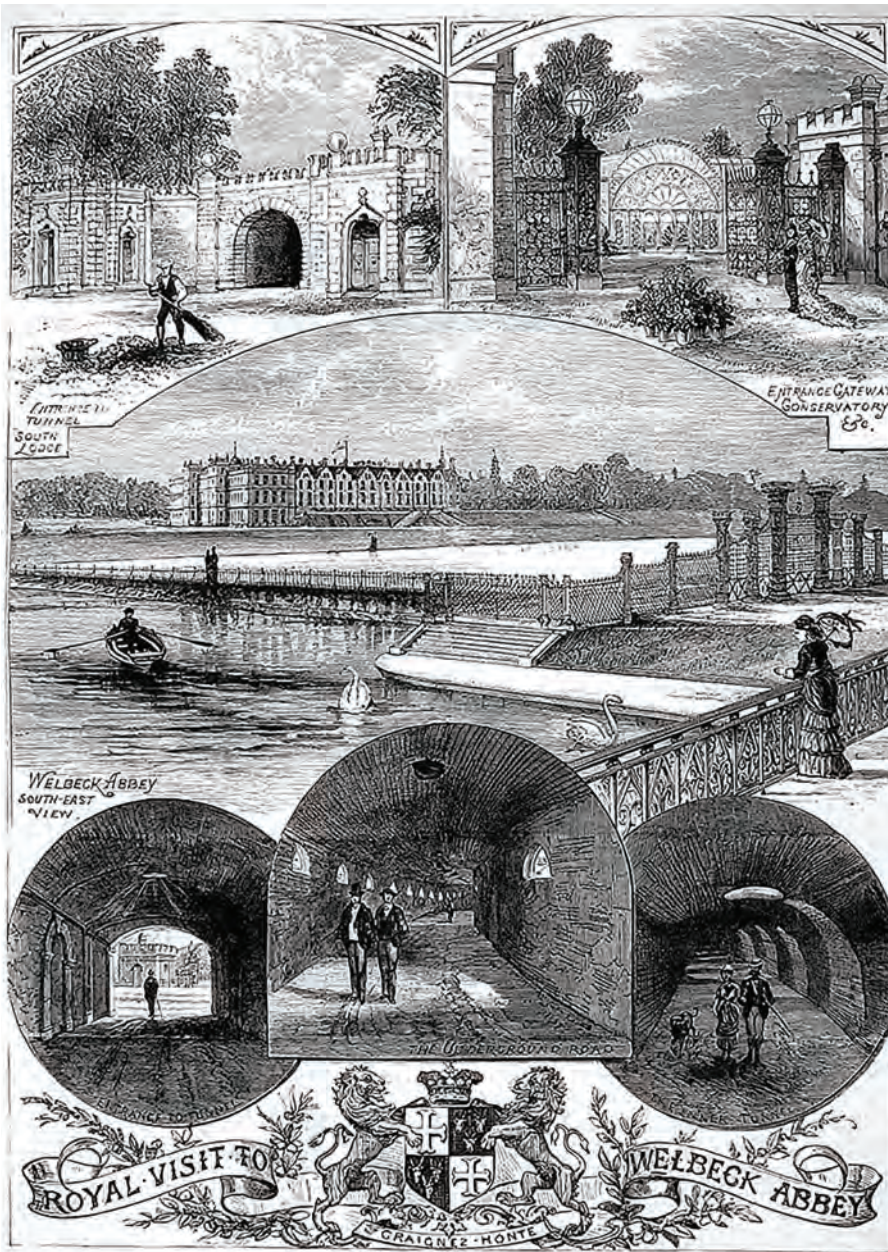
*1920 1:2,500 OS map showing the South Lodge. Tunnel is highlighted in yellow.*

Welbeck Abbey stands in an estate of nearly 3,000 acres. The mansion was until recently partly an army college and partly still in private hands. It is described as neither imposing nor attractive. The house is the result of a complicated and still not fully explored building history, with evidence of the C16 to C19 overlaid by a veneer applied by Sir Ernest George (then of George & Yates) in 1900 – 2 after a disastrous fire. Approached from the west it comprises two stone-built wings arranged in an L-shape, the east wing basically C17 and C18 but much altered in the C19 and C20, the south wing is mainly an C18 remodelling of a C16 wing. The mansion was originally a Premonstratensian house, founded in 1153



*5<sup>th</sup> Duke of Portland*





and by 1512 was recognized as the head house of the order in England. Very little of it survives: seven bays of the undercroft dating from c. 1250, the southernmost three bays with original vaulting, the rest with C18 vaults; and an older doorway of c. 1180. At the Dissolution the estate came into private hands and after several changes into those of Sir Charles Cavendish, son of Bess of Hardwick, who leased it from his brother-in-law Gilbert Talbot in 1597 and bought it ten years later. The predominant human and visual interest of Welbeck is Victorian, connected with the mysterious fifth Duke of Portland, a handsome but 'lonely, self-isolated man', as the step-sister of the sixth Duke, Lady Ottoline Morrell, described him. Most of the strange features of his character are known to us from her, though local legends may gradually have added a great deal. He lived in four or five rooms only, separated from the outer world by a door with two letter-boxes, one for messages and mail in, one out. The rest of the house was mostly empty except for conveniences placed into the corners of the

rooms. The Gothic Hall was stacked full of furniture. The Duke travelled to London in his carriage, which at Worksop was placed on a railway truck, the sun blinds carefully drawn. In the park such acquaintances as the Vicar had orders not to see him when he passed them. From the South Lodge it is another three or four miles by public road to Worksop.

On the other hand he was on friendly and natural terms with the hundreds of workmen employed on his vast and crazy enterprises. Each workman received a donkey and an umbrella when he started work so as to make travelling through the park more comfortable.

The fifth Duke's buildings extend below ground to the west of the house. Among the miles of tunnels one stretches a mile and a half to the old Worksop road. It is wide enough for two carriages to pass, and dips down where it meets the lake. It conveyed the Duke to Worksop safe and unseen whenever a journey could not be avoided. Other tunnels ran to the stables and new riding school. These excavations, by traction engine, steam plough, and teams of Irish navvies, were begun in 1860, six years after the Duke inherited. They were lit by huge glass bullseyes above the ground. The new riding school, 385 by 112 ft. and 52 ft. high, has cast-iron columns and a glass and iron vault. Also above ground are the remains of ranges of hothouses 800 ft. in

length. The Duke liked to grow his own fruit, and so also devised fruit forcing walls with glass roofs, over 700 ft. long. Of other buildings above ground the various lodges in neo-Tudor style may be mentioned, 'more than one can count'. In 1875, four years before the death of the Duke, there were thirty-five lodges, and another six under construction.

The Duke's first work, about 1860, in the house was the demolition of Carr's one-storey chapel of 1763 at the lake end of the south wing and the erection of three-storey additions in its place. The rest of the building was fitted with gas lighting and modern plumbing, including the extraordinary water closets, and railway lines to carry food from the kitchens to the Gothic Hall and dining room were laid!

The underground rooms projecting west from the house are connected to it by underground passages. The first was the suite of library rooms. These are 236 ft. long and lie south of the Smythson riding school. In 1875 a chapel was begun to the west of the library rooms. This room, 154 by 64 ft. with sober classical decoration, was

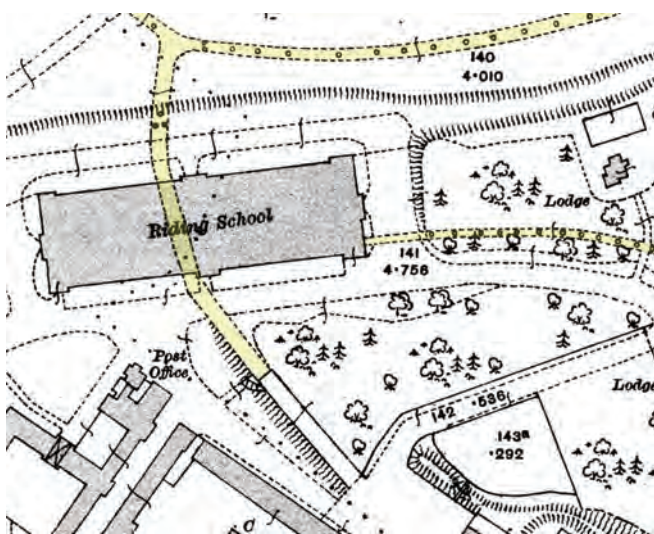




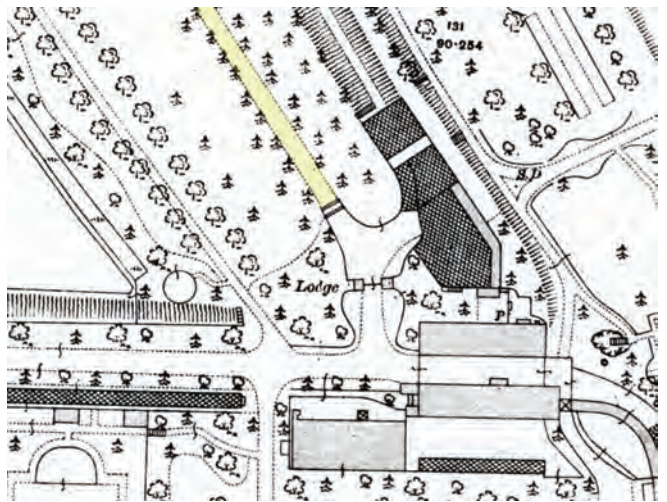
The tunnel entrance near the riding school. Photo Peter Turner. Reproduced from Geograph under creative commons licence



The tunnel entrance near the new service block



1919 1:2,500 OS map showing the Riding School and adjacent tunnel entrance. Tunnels are highlighted in yellow.



1919 1:2,500 OS map showing the new service block (south east of the lodge) and adjacent tunnel entrance.

Tunnel is highlighted in yellow.

soon converted into a ballroom, and the library suite into supper rooms opening off one side of a glass-roofed glass corridor or long conservatory by which they were reached from the ballroom. On the other side of the ballroom, the rose corridor, a similar conservatory, runs west to what was meant to be a huge Bachelors' Hall.

A tour through these vast halls is 'a little disappointing'. The results of the Duke's burrowings are much less cavernous than one might expect. The rooms are not too low down for skylights and are not, therefore, gloomy during the day. At night they were illuminated by literally thousands of gas jets (1,100 alone in the three original library rooms). Their heating was by hot air.

Pevsner speculates on what then made the Duke go underground. Some said that he was concerned about unemployment and wanted to give as many men work as possible, others suggested that he did not want to spoil the original appearance of the house, an unlikely reason considering the singularly unattractive frontages of Welbeck Abbey. 'May it not rather be suggested that the Duke in his excessive, morbid shyness wanted to indulge his *mania aedificandi* without appearing showy?' In the C18 he might have erected a Castle Howard or a Wentworth Woodhouse. Now he chose to hide his buildings, as he chose to hide himself.

When he died in 1879, excavation had just begun for an enormous Bachelors' Hall. Then building stopped at once. The new Duke on his arrival found 'the front drive a grass-grown morass covered with builders' rubbish'. The foundation walls of the sunk hall were converted into an Italianate sunken garden, with a wooden pavilion and pergolas, and the house was made habitable again by the young Duke's stepmother, Lady Bolsover. Then peace reigned again for a while. Building was resumed in 1891, when a library and chapel were fitted into Smythson's riding school.

### An up-to-date account

Tony Waltham has published some additional information about the tunnels, including a map of the central part of the Welbeck Abbey estate and the mansion and other buildings and connecting tunnels. Cellars under the house apparently contained the kitchens which were linked to a subterranean dining room by narrow-gauge railway lines to allow meals to be delivered by trolleys. A tunnel westwards from the mansion leads to the underground ballroom measuring 19 metres by 48 metres near the mansion and then onwards to the stables block and other buildings, which are about 800 metres away. Another tunnel runs about 200 metres northwards from the mansion to join an east-west tunnel from the stables block heading eastwards under the lake to the South Lodge on a public road. This additional east-west tunnel has a length



*The only section of the sprawling tunnel system in the grounds of Welbeck Abbey to remain easily accessible is a short spur tunnel built for a purpose unknown. Note the skylight in the roof. Photo Ben Walker*

of the order of 800 metres or so. About 170 metres of this stretch is an open cutting. The tunnel under the lake, its floor below the water level, was made inside a clay dam, and forms a causeway allowing also an open-air crossing of the water.

Unlike the rock-cut ‘caves’ in Nottingham and Mansfield, the Welbeck tunnels are of shallow ‘cut-and-cover’ form, excavated in weathered Permian mudstone. The walls and ceilings are of brickwork and limestone blocks, most with a plaster lining. Other than at the skylights they are earthed over, some being traceable as long thin ridges of raised ground. The tunnels range from around two metres wide and high, though some could accommodate a coach and horses. A total length of 3,800 metres is suggested. Sadly, the long tunnels have not been accessible since

they were walled up after the Abbey became a military 6<sup>th</sup> form college.

ADLAM, Derek, 2003, Folly or Epitome? The fifth Duke of Portland at Welbeck. *Follies* 15(1)(56), 4 – 5.

ANON, 1892, *Historic houses of the United Kingdom: descriptive, historical, pictorial*. London: Cassell & Co. Ltd.: viii + 328 + (iv) pp [Includes a chapter by Charles EDWARDES on Welbeck Abbey, in fp + pages 1 - 15]

ANON, 1895, English homes. No. XXXVIII. Welbeck Abbey. *Illustrated London News*, 3 August 1895, 142 - 147.

DEAL, Susan, 2004, Welbeck Abbey, an eccentric Duke and an exhumation. *News! Victorian Society South Yorkshire Group*, October 2004, 7 – 8.

PEVSNER, Nikolaus, and Elizabeth WILLIAMSON, 1979, *The buildings of England: Nottinghamshire. 2<sup>nd</sup> edn*. Yale University Press: 448pp [ISBN 978-0-300-09636-1]

WALTHAM, Anthony C., 2018, *Sandstone caves of Nottingham. 4<sup>th</sup> edition*. East Midlands Geological Society: 56pp [Pages 36 – 37 contain some details for the Welbeck tunnels c. 30km north of the city]

We’re pleased to tell you the news that two long-term members of Sub Brit Jason Holdcroft and Louisa Long got married last year. On a lovely sunny day on 23 June 2018, the happy couple got hitched at the Pavilion Gardens in Buxton. This was followed by a honeymoon in the Brighton Harbour Hotel where they happen to have a newly opened underground health spa! When the 1850s building was being renovated workmen discovered a brick-lined lower basement that had been covered over for decades. Candlelit and intimate, it now houses a sauna and steam room. We wish them both well.



